ZooKeys 1216: 265–302 (2024)
DOI: 10.3897/zookeys.1216.132561

Research Article

Nine new spider species of *Belisana* Thorell, 1898 (Araneae, Pholcidae) from karst caves, with a list of species of the genus from Guizhou, southwestern China

Bing Wang[1], Jinglin Li[1], Shuqiang Li[2], Zhiyuan Yao[1]

1 *College of Life Science, Shenyang Normal University, Shenyang 110034, Liaoning, China*
2 *Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China*
Corresponding authors: Zhiyuan Yao (yaozy@synu.edu.cn); Shuqiang Li (lisq@ioz.ac.cn)

Abstract

Species of the spider genus *Belisana* Thorell, 1898 exhibit high diversity in Guizhou, southwestern China. Previously, only eight species of *Belisana* were recorded in Guizhou. In this study, nine new species are described from karst caves: *Belisana bijie* Wang, S. Li & Yao, **sp. nov.**, *B. liupanshui* Wang, S. Li & Yao, **sp. nov.**, *B. majiang* Wang, S. Li & Yao, **sp. nov.**, *B. nayong* Wang, S. Li & Yao, **sp. nov.**, *B. qixingguan* Wang, S. Li & Yao, **sp. nov.**, *B. xiuwen* Wang, S. Li & Yao, **sp. nov.**, *B. yongcong* Wang, S. Li & Yao, **sp. nov.**, *B. zhouxi* Wang, S. Li & Yao, **sp. nov.**, and *B. zunyi* Wang, S. Li & Yao, **sp. nov.** *Belisana zhangi* Tong & Li, 2007 is reported from Guizhou for the first time. In addition, a list of all species of *Belisana* from Guizhou is provided.

Key words: Biodiversity, cellar spiders, daddy-long-legs, invertebrate, morphology, taxonomy

OPEN ACCESS

Academic editor: Alireza Zamani
Received: 20 July 2024
Accepted: 3 October 2024
Published: 25 October 2024

ZooBank: https://zoobank.org/0E173F72-36D3-4B97-BC43-F096067A3D1E

Citation: Wang B, Li J, Li S, Yao Z (2024) Nine new spider species of *Belisana* Thorell, 1898 (Araneae, Pholcidae) from karst caves, with a list of species of the genus from Guizhou, southwestern China. ZooKeys 1216: 265–302. https://doi.org/10.3897/zookeys.1216.132561

Copyright: © Bing Wang et al.
This is an open access article distributed under terms of the Creative Commons Attribution License (Attribution 4.0 International – CC BY 4.0).

Introduction

Belisana Thorell, 1898, the second largest genus in the Pholcidae C.L. Koch, 1850, comprises 160 species (WSC 2024). These species inhabit diverse micro-habitats, e.g., beneath rocks, in caves, on the underside of leaves, among leaf litter, and amidst foliage in the canopy (Huber 2005; Yao et al. 2015; Zhao et al. 2023a). They are primarily distributed in southern China, as well as in the Indo-Malayan and Australasian regions (Huber 2005; Yao and Li 2013; Yao et al. 2018; Zhu et al. 2020; Zhu and Li 2021). Currently, 46% of the species (74 spp.) have been documented from southern China (WSC 2024), of which Yunnan boasts the highest concentration of species, accounting for 42% (31 spp.; Zhang et al. 2024b). Guangxi and Hainan, which have the second and third highest species diversity of *Belisana*, respectively, have recorded only 11 and ten species. Recently, numerous surveys targeting pholcid spiders have been conducted in China, resulting in the discovery and reporting of a large number of new species (e.g., Yao et al. 2021; Lu et al. 2022; Zhao et al. 2023b; Yang et al. 2024a, b). Nevertheless, these efforts have primarily focused on *Pholcus* Walckenaer, 1805, found in epigean environments in northern and central

China, with relatively few reports on *Belisana* from hypogean environments in southern China (10 spp.; Wang et al. 2024; Zhang et al. 2024a, b).

Guizhou, located in the southwest of China, is renowned for its abundant karst caves. The extreme cave environmental conditions have been regarded as the primary factors of maintaining species endemism within caves (Lefébure et al. 2006; Yao et al. 2016). Nevertheless, only eight endemic species of *Belisana* have been recorded from Guizhou (Chen et al. 2009; Zhang and Peng 2011; Chen et al. 2016; Yang et al. 2023a; Wang et al. 2024). Among these, seven species are collected from caves. This work aims to report the nine new species, a new record found in karst caves (Fig. 1), and to provide an updated list of species of *Belisana* from Guizhou (Table 1).

Materials and methods

Specimens were examined and measured with a Leica M205 C stereomicroscope. Left male palps were photographed. Epigynes were photographed before dissection. Vulvae were photographed after treating them in a 10% warm solution of potassium hydroxide (KOH) to dissolve soft tissues. Images were captured with a Canon EOS 750D wide zoom digital camera (24.2 megapixels) mounted on the stereomicroscope mentioned above and assembled using Helicon Focus v. 3.10.3 image stacking software (Khmelik et al. 2005). Drawings were done with Procreate 5.0.2 (Savage Interactive Pty. Ltd.). All measurements are given in millimeters (mm). Leg measurements are shown as: total length (femur, patella, tibia, metatarsus, tarsus). Leg segments were measured on their dorsal sides. The distribution map was generated with ArcGIS v. 10.2 (ESRI Inc.). The specimens studied are preserved in 75% ethanol and deposited in the Institute of Zoology, Chinese Academy of Sciences (**IZCAS**) in Beijing, China.

Table 1. A list of species of *Belisana* from Guizhou, China.

No.	Species	Habitat	Reference
1	*B. bijie* sp. nov.	karst cave	this paper
2	*B. daji* Chen, Zhang & Zhu, 2009	karst cave	Chen et al. (2009)
3	*B. douqing* Chen, Zhang & Zhu, 2009	karst cave	Chen et al. (2009)
4	*B. galeiformis* Zhang & Peng, 2011	/	Zhang and Peng (2011)
5	*B. lii* Chen, Yu & Guo, 2016	karst cave	Chen et al. (2016)
6	*B. liupanshui* sp. nov.	karst cave	this paper
7	*B. majiang* sp. nov.	karst cave	this paper
8	*B. nayong* sp. nov.	karst cave	this paper
9	*B. qixingguan* sp. nov.	karst cave	this paper
10	*B. wangchengi* Wang, Yao & Zhang, 2024	karst cave	Wang et al. (2024)
11	*B. xishui* Chen, Zhang & Zhu, 2009	karst cave	Chen et al. (2009)
12	*B. xiuwen* sp. nov.	karst cave	this paper
13	*B. yanhe* Chen, Zhang & Zhu, 2009	karst cave	Chen et al. (2009)
14	*B. yongcong* sp. nov.	karst cave	this paper
15	*B. yuhaoi* Yang & Yao, 2023	karst cave	Yang et al. (2023a)
16	*B. zhangi* Tong & Li, 2007	karst cave	this paper; Tong and Li (2007)
17	*B. zhouxi* sp. nov.	karst cave	this paper
18	*B. zunyi* sp. nov.	karst cave	this paper

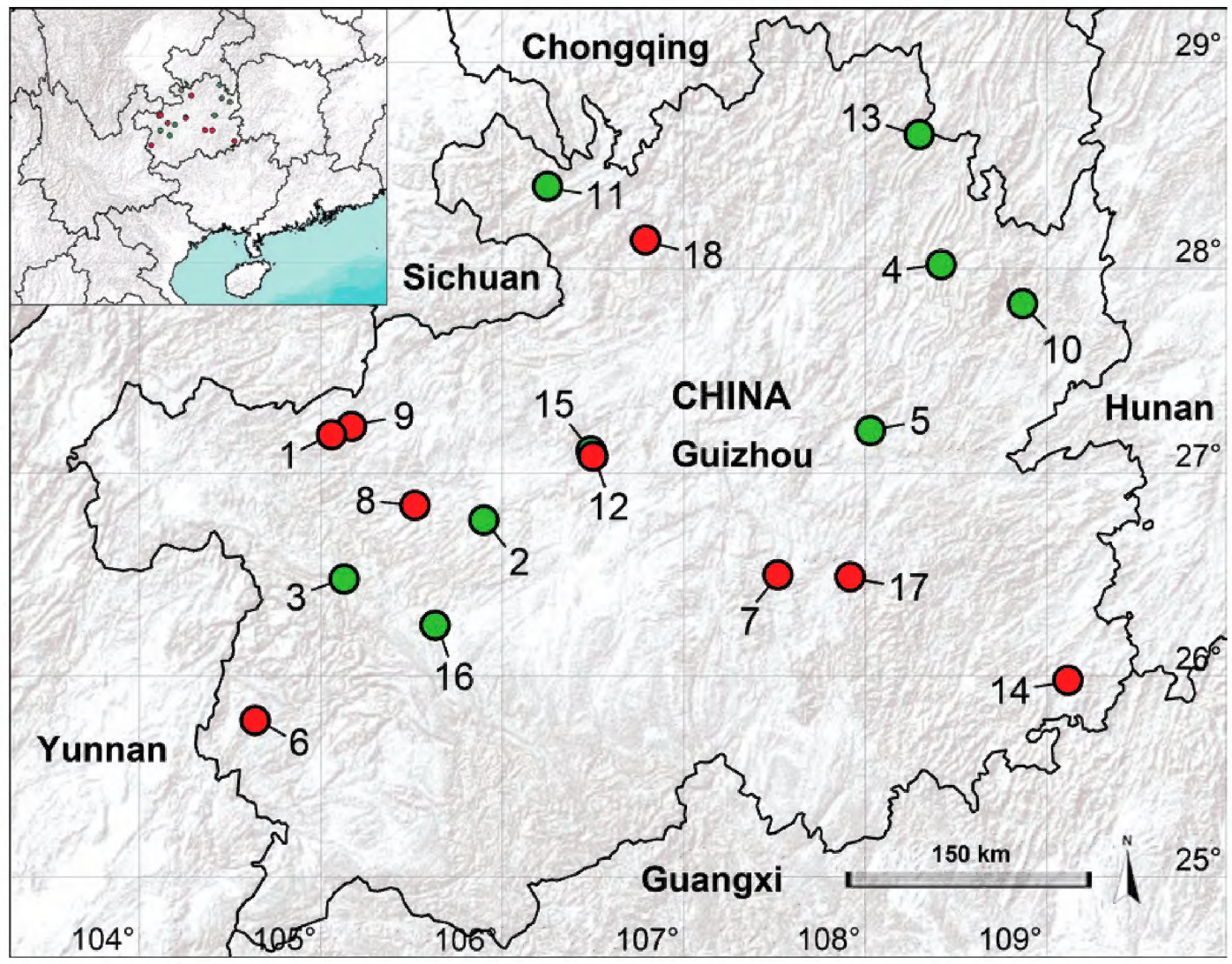


Figure 1. Distribution records of the *Belisana* species from Guizhou, China **1** *Belisana bijie* sp. nov. **2** *B. daji* Chen, Zhang & Zhu, 2009 **3** *B. douqing* Chen, Zhang & Zhu, 2009 **4** *B. galeiformis* Zhang & Peng, 2011 **5** *B. lii* Chen, Yu & Guo, 2016 **6** *B. liupanshui* sp. nov. **7** *B. majiang* sp. nov. **8** *B. nayong* sp. nov. **9** *B. qixingguan* sp. nov. **10** *B. wangchengi* Wang, Yao & Zhang, 2024 **11** *B. xishui* Chen, Zhang & Zhu, 2009 **12** *B. xiuwen* sp. nov. **13** *B. yanhe* Chen, Zhang & Zhu, 2009 **14** *B. yongcong* sp. nov. **15** *B. yuhaoi* Yang & Yao, 2023 **16** *B. zhangi* Tong & Li, 2007 **17** *B. zhouxi* sp. nov. **18** *B. zunyi* sp. nov.

Terminology and taxonomic descriptions follow Huber (2005) and Yao et al. (2015). The following abbreviations are used: **aa** = anterior arch, **ALE** = anterior lateral eye, **b** = bulb, **ba** = bulbal apophysis, **da** = distal apophysis, **e** = embolus, **ep** = epigynal pocket, **f** = flap, **L/d** = length/diameter, **pa** = proximo-lateral apophysis, **PME** = posterior median eye, **pp** = pore plate, **pr** = procursus.

Taxonomy

Family Pholcidae C.L. Koch, 1850

Subfamily Pholcinae C.L. Koch, 1850

Genus *Belisana* Thorell, 1898

Type species. *Belisana tauricornis* Thorell, 1898.

Belisana bijie Wang, S. Li & Yao, sp. nov.

https://zoobank.org/938091C8-867C-4607-9EB1-9B4BE301F78F
Figs 2, 3, 22A, B, 24A, B

Type material. ***Holotype*: China** • ♂; Guizhou, Bijie, Qixingguan District, Salaxi Town, Shuanglongdao Cave; 27°11.493'N, 105°03.850'E; alt. 1920 m; 18 Nov. 2011; Z. Chen & Z. Zha leg.; IZCAS-Ar45175. ***Paratype*: China** • 1♀; same data as for holotype; IZCAS-Ar45176.

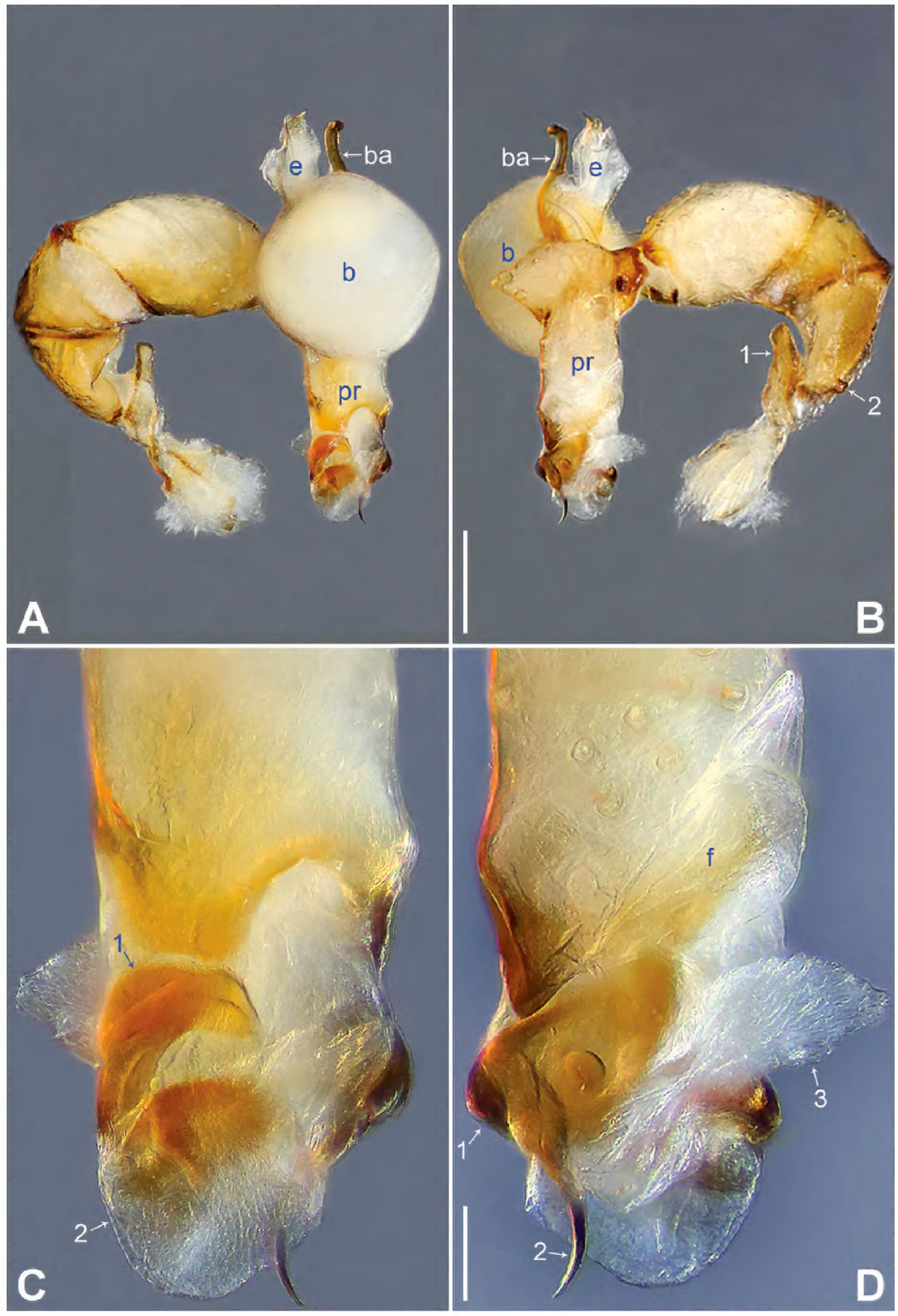


Figure 2. *Belisana bijie* sp. nov., holotype male **A, B** palp (**A** prolateral view **B** retrolateral view, arrow 1 points at ventral apophysis, arrow 2 points at retrolatero-proximal protrusion) **C, D** distal part of procursus (**C** prolateral view, arrow 1 points at prolatero-subdistal sclerite, arrow 2 points at prolatero-distal membranous lamella **D** retrolateral view, arrow 1 points at sclerotized dorso-subdistal apophysis, arrow 2 points at retrolatero-distal spine, arrow 3 points at retrolatero-subdistal membranous process). Abbreviations: b = bulb, ba = bulbal apophysis, e = embolus, f = flap, pr = procursus. Scale bars: 0.20 (**A, B**); 0.05 (**C, D**).

Diagnosis. The new species resembles *B. wangchengi* Wang, Yao & Zhang, 2024 (Wang et al. 2024: 2, figs 1A–D, 2A–H, 3A–D) by having similar male chelicerae (tips of distal apophyses widely separated and pointing inwards; Fig. 3D), bulbal apophysis (hooked; Fig. 3C), and epigyne (epigynal pockets on lateral part of epigynal plate; Figs 3A, 24A), but can be distinguished by procursus with retrolatero-subdistal membranous process (arrow 3 in Figs 2D, 22B vs absent), by vulval pore plates with nearly angular sclerites (arrow in Figs 3B, 24B vs

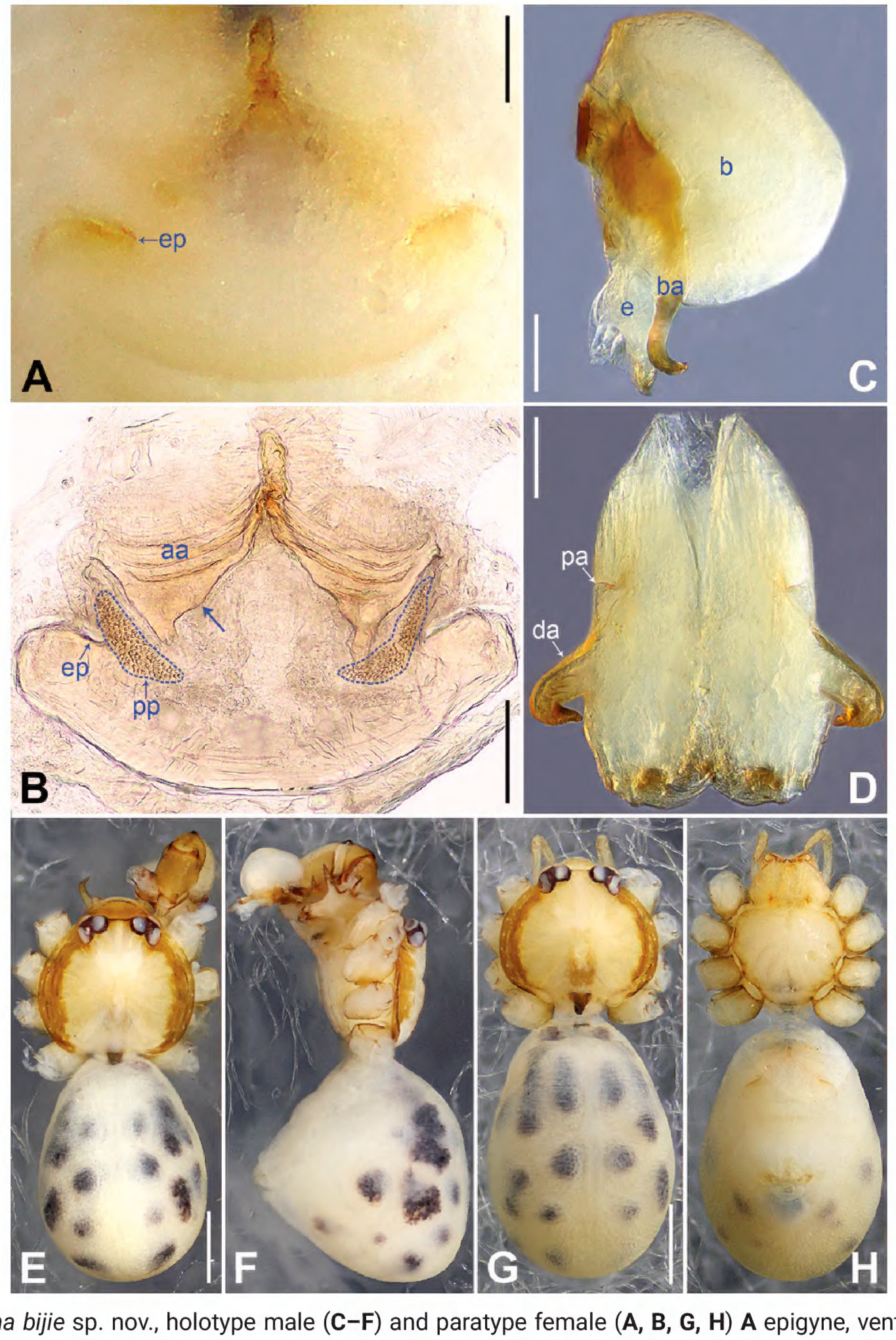


Figure 3. *Belisana bijie* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A** epigyne, ventral view **B** vulva, dorsal view, arrow points at lateral sclerite **C** bulb, prolateral view **D** chelicerae, frontal view **E–H** habitus (**E, G** dorsal view **F** lateral view **H** ventral view). Abbreviations: aa = anterior arch, b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.10 (**A–D**); 0.40 (**E–H**).

blunt), and by dorsal shield of prosoma with lateral brown bands (Fig. 3E, G vs absent, but with median radiating marks).

Description. Male (**holotype**): Total length 1.95 (2.08 with clypeus), prosoma 0.70 long, 0.82 wide, opisthosoma 1.25 long, 0.90 wide. Leg I: 19.96 (5.13, 0.38, 5.05, 7.52, 1.88), leg II: 13.25 (3.52, 0.37, 3.32, 4.70, 1.34), leg III: 7.81 (2.25, 0.30, 1.90, 2.59, 0.77), leg IV: 9.83 (3.09, 0.30, 2.45, 3.16, 0.83); tibia I L/d: 73. Eye interdistances and diameters: PME–PME 0.11, PME 0.10, PME–ALE 0.02. Sternum width/length: 0.63/0.56. Habitus as in Fig. 3E, F. Dorsal shield of prosoma yellowish, with brown lateral bands; clypeus brown; sternum yellowish.

Legs whitish, without darker rings. Opisthosoma yellowish, with black spots. Thoracic furrow absent. Clypeus unmodified. Chelicerae with pair of proximo-lateral apophyses (pa in Fig. 3D) and pair of curved distal apophyses (distance between tips: 0.31; da in Fig. 3D). Palp as in Fig. 2A, B; trochanter with ventral apophysis (2× longer than wide, arrow 1 in Fig. 2B); femur with retrolatero-proximal protrusion (arrow 2 in Fig. 2B); procursus simple proximally but complex distally, with prolatero-subdistal sclerite (arrow 1 in Figs 2C, 22A), prolatero-distal membranous lamella (arrow 2 in Figs 2C, 22A) bearing proximally sclerotized part, sclerotized dorso-subdistal apophysis (arrow 1 in Figs 2D, 22B), retrolatero-distal spine (arrow 2 in Figs 2D, 22B), retrolatero-subdistal membranous process (arrow 3 in Figs 2D, 22B), and retrolateral membranous flap (f in Figs 2D, 22B); bulb with hooked apophysis (ba in Fig. 3C) and simple embolus (e in Fig. 3C). Retrolateral trichobothria on tibia I at 9% proximally; legs with short vertical setae on metatarsi; tarsus I with 17 distinct pseudosegments.

Female (**paratype**, IZCAS-Ar45176): Similar to male, habitus as in Fig. 3G, H. Total length 1.96 (2.09 with clypeus), prosoma 0.66 long, 0.83 wide, opisthosoma 1.30 long, 1.01 wide; tibia I: 3.40; tibia I L/d: 49. Eye interdistances and diameters: PME–PME 0.10, PME 0.10, PME–ALE 0.02. Sternum width/length: 0.60/0.53. Dorsal shield of prosoma with distinct postero-median marks; clypeus yellowish. Epigyne simple and flat, posteriorly curved, with pair of lateral pockets 0.31 apart (ep in Figs 3A, 24A). Vulva with ridge-shaped anterior arch bearing pair of nearly angular sclerites (arrow in Figs 3B, 24B), and pair of nearly triangular pore plates (4× longer than wide, pp in Figs 3B, 24B).

Habitat. The species was found in the dark zone inside the cave.

Distribution. China (Guizhou, type locality; Fig. 1).

Etymology. The specific name refers to the type locality; noun in apposition.

***Belisana liupanshui* Wang, S. Li & Yao, sp. nov.**

https://zoobank.org/4C5D21CD-86E7-43FA-B974-0235DB601B2B

Figs 4, 5, 22C, D, 24C, D

Type material. ***Holotype*: China** • ♂; Guizhou, Liupanshui, Pan County, Biyun Cave; 25°46.527'N, 104°38.278'E; alt. 1468 m; 13 Apr. 2007; J. Liu & Y. Lin leg.; IZCAS-Ar45181. ***Paratypes*: China** • 5♂; same data as for holotype; IZCAS-Ar45182–86 • 7♀; same data as for holotype; IZCAS-Ar45187–93.

Diagnosis. The new species resembles *B. jiuxiang* Zhang, Li & Yao, 2024 (Zhang et al. 2024b: 261, figs 4A–D, 5A–H, 18C, D, 20C, D) by having similar male chelicerae (distal apophyses directed towards frontally, but tips pointing inwards; Fig. 5D) and epigyne (epigynal pockets on median part of epigynal plate, epigynal plate posteriorly straight; Figs 5A, 24C), but can be distinguished by procursus with prolatero-subdistal and subdistal membranous processes (arrows 1, 3 in Figs 4C, 22C vs absent) and nearly rectangle dorso-subdistal membranous process (arrow 4 in Figs 4C, 22C vs angular), by bulbal apophysis with angular subdistal apophysis (arrow in Fig. 5C vs absent), and by vulval pore plates anteriorly narrow and posteriorly wide (pp in Figs 5B, 24D vs nearly quadrilateral).

Description. Male (**holotype**): Total length 1.71 (1.79 with clypeus), prosoma 0.63 long, 0.67 wide, opisthosoma 1.08 long, 0.81 wide. Leg I: – (4.04, 0.29, 4.50, 5.96, –), leg II: 11.08 (2.80, 0.30, 2.97, 3.92, 1.09), leg III: 7.98 (2.22, 0.25,

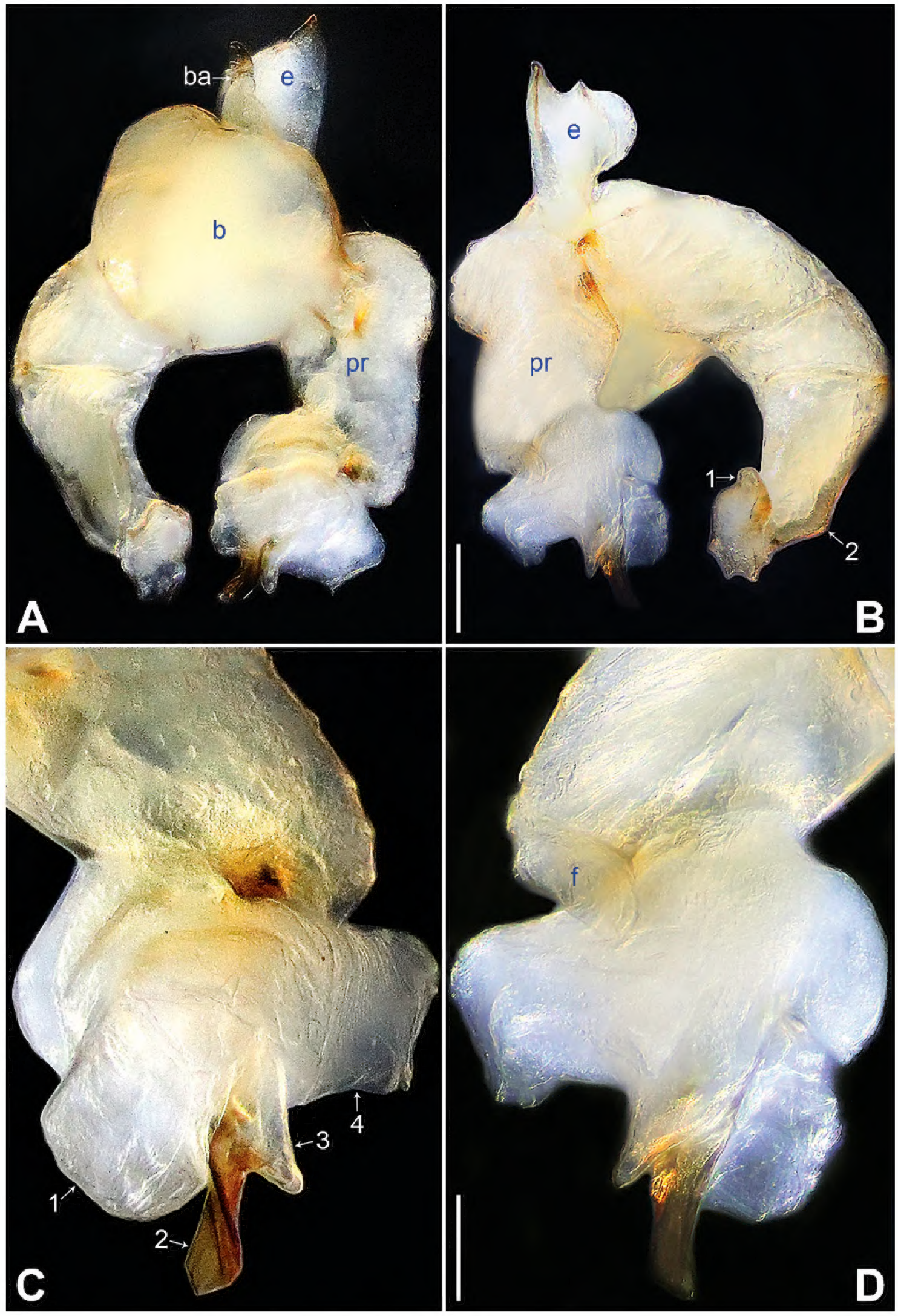


Figure 4. *Belisana liupanshui* sp. nov., holotype male **A, B** palp (**A** prolateral view **B** retrolateral view, arrow 1 points at ventral apophysis, arrow 2 points at retrolatero-proximal protrusion) **C, D** distal part of procursus (**C** prolateral view, arrow 1 points at prolatero-subdistal membranous process, arrow 2 points at sclerotized distal apophysis, arrow 3 points at subdistal membranous process, arrow 4 points at dorso-subdistal membranous process **D** retrolateral view). Abbreviations: b = bulb, ba = bulbal apophysis, e = embolus, f = flap, pr = procursus. Scale bars: 0.10 (**A, B**); 0.05 (**C, D**).

1.98, 2.72, 0.81), leg IV: 10.20 (3.00, 0.26, 2.63, 3.45, 0.86); tibia I L/d: 63. Eye interdistances and diameters: PME–PME 0.09, PME 0.08, PME–ALE 0.02. Sternum width/length: 0.51/0.44. Habitus as in Fig. 5E, F. Dorsal shield of prosoma yellowish, with brownish radiating marks; clypeus brownish; sternum yellowish.

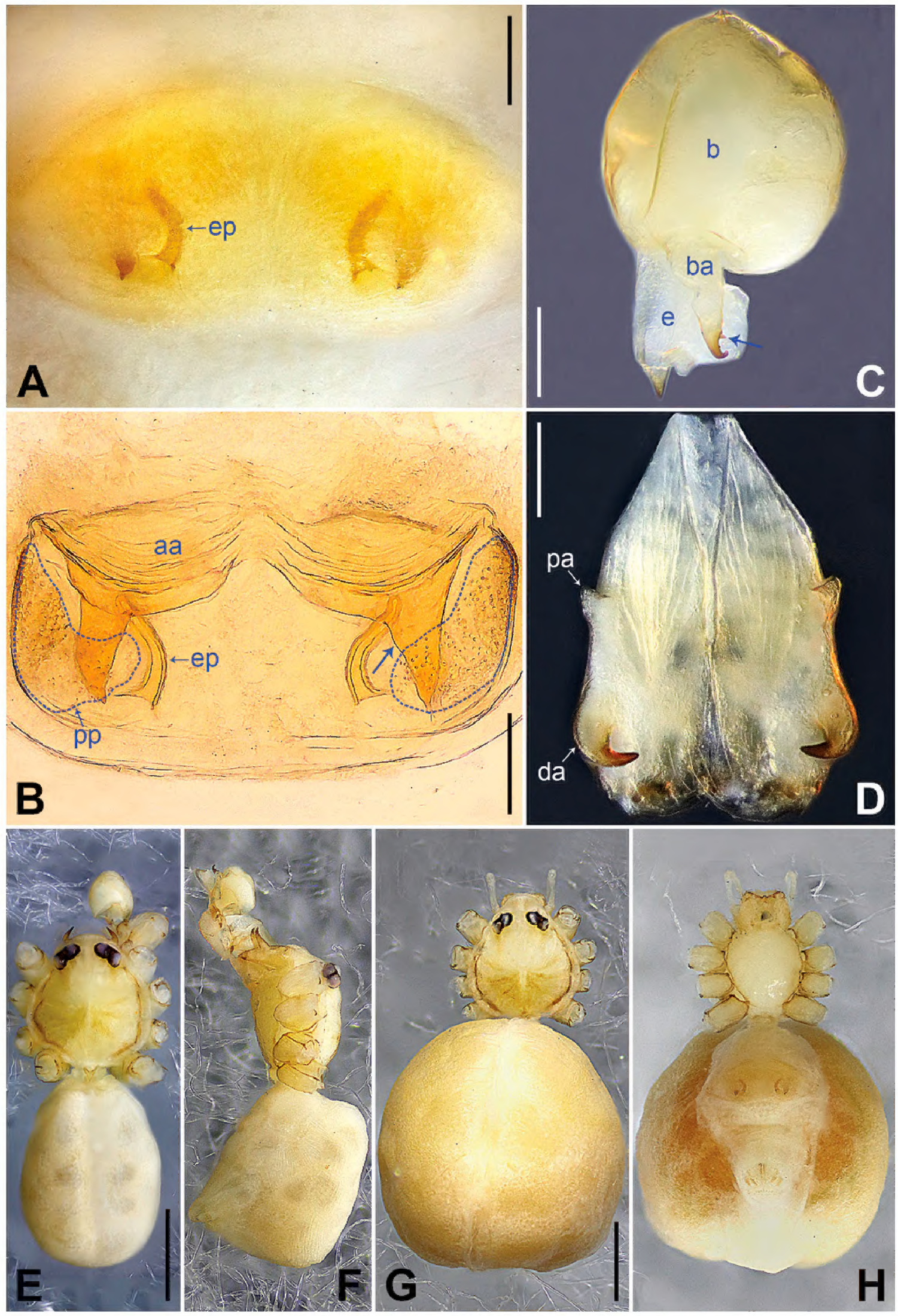


Figure 5. *Belisana liupanshui* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A** epigyne, ventral view **B** vulva, dorsal view, arrow points at lateral sclerite **C** bulb, prolateral view, arrow points at subdistal apophysis **D** chelicerae, frontal view **E–H** habitus (**E, G** dorsal view **F** lateral view **H** ventral view). Abbreviations: aa = anterior arch, b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.10 (**A–D**); 0.50 (**E–H**).

Legs whitish, without darker rings. Opisthosoma yellowish, without spots. Thoracic furrow absent. Clypeus unmodified. Chelicerae with pair of proximo-lateral apophyses (pa in Fig. 5D) and pair of curved distal apophyses (distance between tips: 0.17; da in Fig. 5D). Palp as in Fig. 4A, B; trochanter with ventral

apophysis (as long as wide, arrow 1 in Fig. 4B); femur with retrolatero-proximal protrusion (arrow 2 in Fig. 4B); procursus simple proximally but complex distally, with prolatero-subdistal membranous process (arrow 1 in Figs 4C, 22C), sclerotized distal apophysis (arrow 2 in Figs 4C, 22C), subdistal membranous process (arrow 3 in Figs 4C, 22C), dorso-subdistal membranous process (arrow 4 in Figs 4C, 22C), and retrolateral membranous flap (f in Figs 4D, 22D); bulb with hooked apophysis bearing angular subdistal apophysis (arrow in Fig. 5C) and simple embolus (e in Fig. 5C). Retrolateral trichobothria on tibia I at 4% proximally; legs with short vertical setae on metatarsi.

Female (**paratype**, IZCAS-Ar45187): Similar to male, habitus as in Fig. 5G, H. Total length 2.53 (2.65 with clypeus), prosoma 0.67 long, 0.75 wide, opisthosoma 1.86 long, 1.80 wide; tibia I: 4.05; tibia I L/d: 51. Eye interdistances and diameters: PME–PME 0.11, PME 0.07, PME–ALE 0.02. Sternum width/length: 0.52/0.46. Epigyne simple and flat, posteriorly straight, with pair of median pockets 0.20 apart (ep in Figs 5A, 24C). Vulva with ridge-shaped anterior arch bearing pair of angular lateral sclerites (arrow in Figs 5B, 24D), and pair of anteriorly narrow and posteriorly wide pore plates (3× longer than wide, pp in Figs 5B, 24D).

Variation. Tibia I in five male paratypes (IZCAS-Ar45182–86): 4.50, 4.55, 4.62, 4.65, 4.70. Tibia I in the other six female paratypes (IZCAS-Ar45188–93): 3.56–3.85.

Habitat. The species was found in the dark zone inside the cave.

Distribution. China (Guizhou, type locality; Fig. 1).

Etymology. The specific name refers to the type locality; noun in apposition.

***Belisana majiang* Wang, S. Li & Yao, sp. nov.**

https://zoobank.org/75C0DB39-2F6A-40D1-93A0-3C85CD956A53

Figs 6, 7, 22E, F, 24E, F

Type material. ***Holotype*: China** • ♂; Guizhou, Kaili, Majiang County, Xingshan Town, Gubin Village, Guazhutou Cave; 26°30.257'N, 107°30.943'E; alt. 1056 m; 28 Nov. 2011; Z. Chen & Z. Zha leg.; IZCAS-Ar45194. ***Paratypes*: China** • 1♂; same data as for holotype; IZCAS-Ar45195 • 2♀; same data as for holotype; IZCAS-Ar45196–97.

Diagnosis. The new species resembles *B. zhouxi* sp. nov. (Figs 18, 19, 23E, F, 25G, H) by having similar male chelicerae (tips of distal apophyses pointing downwards; Fig. 7D), bulbal apophysis (hooked; Fig. 7C), and epigyne (epigynal pockets on antero-lateral part of epigynal plate, epigynal plate posteriorly curved; Figs 7A, 24E), but can be distinguished by procursus with distinct ventro-subdistal membranous process and dorso-distal spine (arrows 1, 3 in Figs 6C, 22E vs absent) and by vulval pore plates long elliptic (3× longer than wide, pp in Figs 7B, 24F vs 2×); also distinguished from *B. tongle* Zhang, Chen & Zhu, 2008 (Zhang et al. 2008: 654, figs 1–5) by procursus with dorso-subdistal membranous process (arrow 4 in Figs 6C, 22E vs absent), by prolatero-distal membranous lamella of procursus without rectangular sclerite (arrow 2 in Figs 6C, 22E vs present), by ventro-subdistal membranous process of procursus 3× longer than wide (arrow 1 in Figs 6C, 22E vs 8×), and by dorso-distal spine of procursus 6× longer than wide (arrow 3 in Figs 6C, 22E vs 12×).

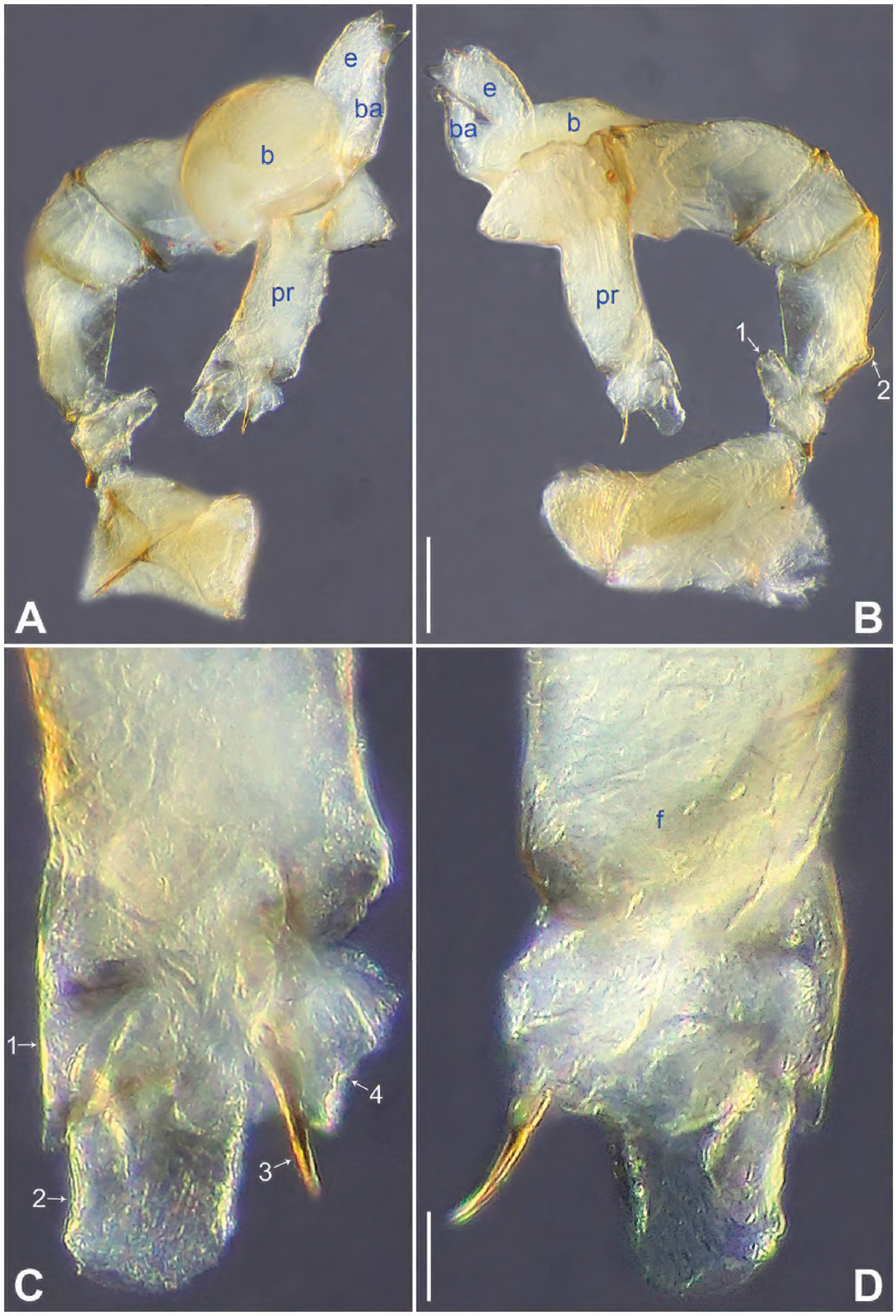


Figure 6. *Belisana majiang* sp. nov., holotype male **A, B** palp (**A** prolateral view **B** retrolateral view, arrow 1 points at ventral apophysis, arrow 2 points at retrolatero-proximal protrusion) **C, D** distal part of procursus (**C** prolateral view, arrow 1 points at ventro-subdistal membranous process, arrow 2 points at prolatero-distal membranous lamella, arrow 3 points at dorso-distal spine, arrow 4 points at dorso-subdistal membranous process **D** retrolateral view). Abbreviations: b = bulb, ba = bulbal apophysis, e = embolus, f = flap, pr = procursus. Scale bars: 0.10 (**A, B**); 0.02 (**C, D**).

Description. Male (holotype): Total length 1.35 (1.43 with clypeus), prosoma 0.52 long, 0.59 wide, opisthosoma 0.83 long, 0.64 wide. Leg I missing, leg II: 6.13 (1.78, 0.22, 1.50, 1.90, 0.73), leg III: 4.19 (1.28, 0.20, 0.95, 1.33, 0.43), leg IV: 5.87 (1.72, 0.22, 1.48, 1.80, 0.65). Eye interdistances and diameters: PME–PME 0.08, PME 0.06, PME–ALE 0.02. Sternum width/length: 0.44/0.38. Habitus

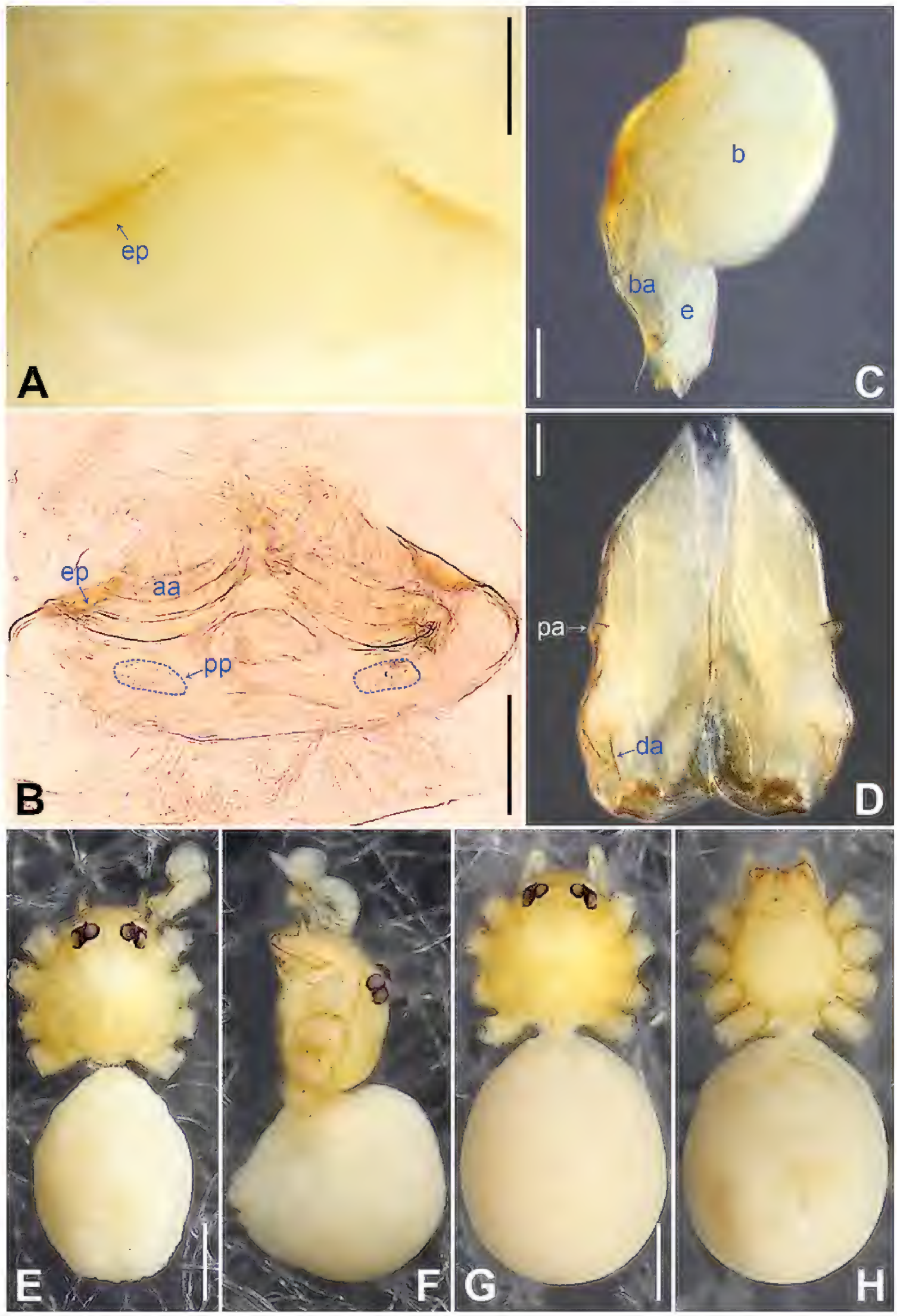


Figure 7. *Belisana majiang* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A** epigyne, ventral view **B** vulva, dorsal view **C** bulb, prolateral view **D** chelicerae, frontal view **E–H** habitus (**E, G** dorsal view **F** lateral view **H** ventral view). Abbreviations: aa = anterior arch, b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.05 (**A–D**); 0.30 (**E–H**).

as in Fig. 7E, F. Dorsal shield of prosoma yellowish, without marks; clypeus and sternum yellowish. Legs whitish, without darker rings. Opisthosoma yellowish, without spots. Thoracic furrow absent. Clypeus unmodified. Chelicerae with pair of proximo-lateral apophyses (pa in Fig. 7D) and pair of curved distal apophyses (distance between tips: 0.19; da in Fig. 7D). Palp as in Fig. 6A, B;

trochanter with ventral apophysis (1.5× longer than wide, arrow 1 in Fig. 6B); femur with retrolatero-proximal protrusion (arrow 2 in Fig. 6B); procursus simple proximally but complex distally, with ventro-subdistal membranous process (arrow 1 in Figs 6C, 22E), prolatero-distal membranous lamella (arrow 2 in Figs 6C, 22E) bearing proximally slightly sclerotized part, dorso-distal spine (arrow 3 in Figs 6C, 22E), dorso-subdistal membranous process (arrow 4 in Figs 6C, 22E), and retrolateral membranous flap (f in Figs 6D, 22F); bulb with hooked apophysis (ba in Fig. 7C) and simple embolus (e in Fig. 7C).

Female (**paratype**, IZCAS-Ar45196): Similar to male, habitus as in Fig. 7G, H. Total length 1.48 (1.58 with clypeus), prosoma 0.48 long, 0.56 wide, opisthosoma 1.00 long, 0.84 wide. Eye interdistances and diameters: PME–PME 0.08, PME 0.06, PME–ALE 0.02. Sternum width/length: 0.43/0.39. Epigyne simple and flat, posteriorly curved, with pair of antero-lateral pockets 0.14 apart (ep in Figs 7A, 24E). Vulva with ridge-shaped anterior arch (aa in Figs 7B, 24F) and pair of long elliptic pore plates (3× longer than wide, pp in Figs 7B, 24F).

Variation. Unknown. Legs I missing in male paratype (IZCAS-Ar45195) and another female paratype (IZCAS-Ar45197).

Habitat. The species was found in the dark zone inside the cave.

Distribution. China (Guizhou, type locality; Fig. 1).

Etymology. The specific name refers to the type locality; noun in apposition.

***Belisana nayong* Wang, S. Li & Yao, sp. nov.**

https://zoobank.org/2374804C-1CDB-4013-885E-336618ED0D2B

Figs 8, 9, 22G, H, 24G, H

Type material. ***Holotype*: China** • ♂; Guizhou, Bijie, Nayong County, Laosiba Town, Bailong Cave; 26°50.166'N, 105°31.222'E; alt. 1468 m; 27 Apr. 2007; J. Liu & Y. Lin leg.; IZCAS-Ar45198. ***Paratypes*: China** • 3♂; same data as for holotype; IZCAS-Ar45199–201 • 4♀; same data as for holotype; IZCAS-Ar45202–05.

Diagnosis. The new species resembles *B. yongcong* sp. nov. (Figs 14, 15, 23A, B, 25C, D) by having similar bulbal apophysis (hooked; Fig. 9C) and vulva (anterior arch ridge-shaped, pore plates curved, long elliptic and 8× longer than wide; Figs 9B, 24H), but can be distinguished by procursus with pointed ventro-subdistal membranous process (arrow 1 in Figs 8C, 22G vs blunt), by male cheliceral distal apophyses pointing inwards (da in Fig. 9D vs outwards), and by epigyne with postero-median pockets (ep in Figs 9A, 24G vs lateral).

Description. Male (**holotype**): Total length 2.33 (2.50 with clypeus), prosoma 0.86 long, 0.89 wide, opisthosoma 1.47 long, 1.15 wide. Leg I: 31.51 (8.33, 0.42, 7.82, 13.08, 1.86), leg II missing, leg III: 19.77 (5.08, 0.39, 5.04, 7.88, 1.38), leg IV missing; tibia I L/d: 89. Eye interdistances and diameters: PME–PME 0.10, PME 0.10, PME–ALE 0.02. Sternum width/length: 0.68/0.64. Habitus as in Fig. 9E, F. Dorsal shield of prosoma yellowish, with brown radiating marks; clypeus brown; sternum yellowish. Legs whitish, without darker rings. Opisthosoma yellowish, without spots. Thoracic furrow absent. Clypeus unmodified. Chelicerae with pair of proximo-lateral apophyses (pa in Fig. 9D) and pair of curved distal apophyses (distance between tips: 0.02; da in Fig. 9D). Palp as in Fig. 8A, B; trochanter with ventral apophysis (as long as wide, arrow 1 in Fig. 8B); femur with retrolatero-proximal protrusion (arrow 2 in Fig. 8B); procursus simple

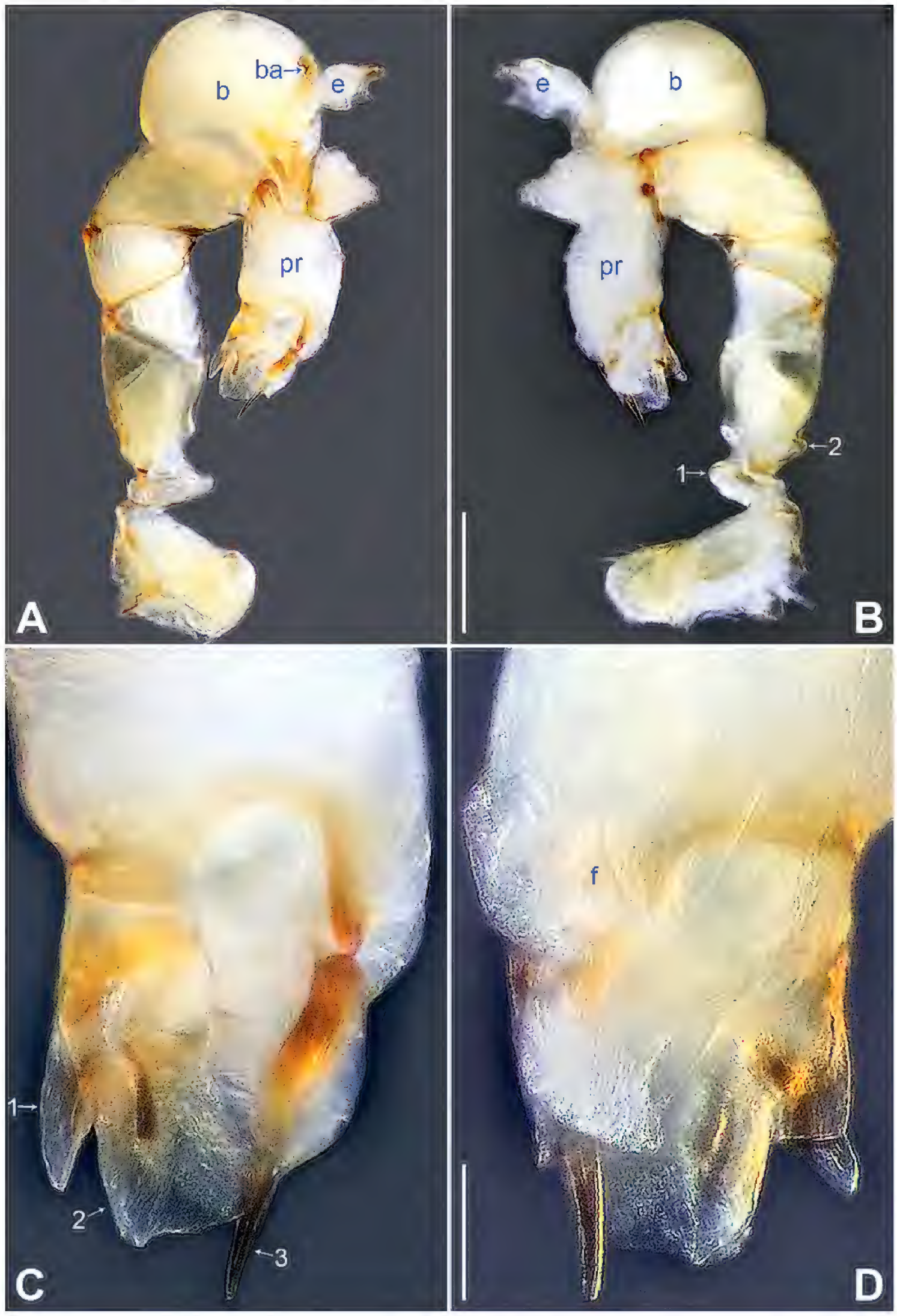


Figure 8. *Belisana nayong* sp. nov., holotype male **A, B** palp (**A** prolateral view **B** retrolateral view, arrow 1 points at ventral apophysis, arrow 2 points at retrolatero-proximal protrusion) **C, D** distal part of procursus (**C** prolateral view, arrow 1 points at ventro-subdistal membranous process, arrow 2 points at prolatero-distal membranous lamella, arrow 3 points at dorso-distal spine **D** retrolateral view). Abbreviations: b = bulb, ba = bulbal apophysis, e = embolus, f = flap, pr = procursus. Scale bars: 0.20 (**A, B**); 0.05 (**C, D**).

proximally but complex distally, with ventro-subdistal membranous process (arrow 1 in Figs 8C, 22G), prolatero-distal membranous lamella (arrow 2 in Figs 8C, 22G) bearing proximally sclerotized part, dorso-distal spine (arrow 3 in Figs 8C, 22G), and retrolateral membranous flap (f in Figs 8D, 22H); bulb with

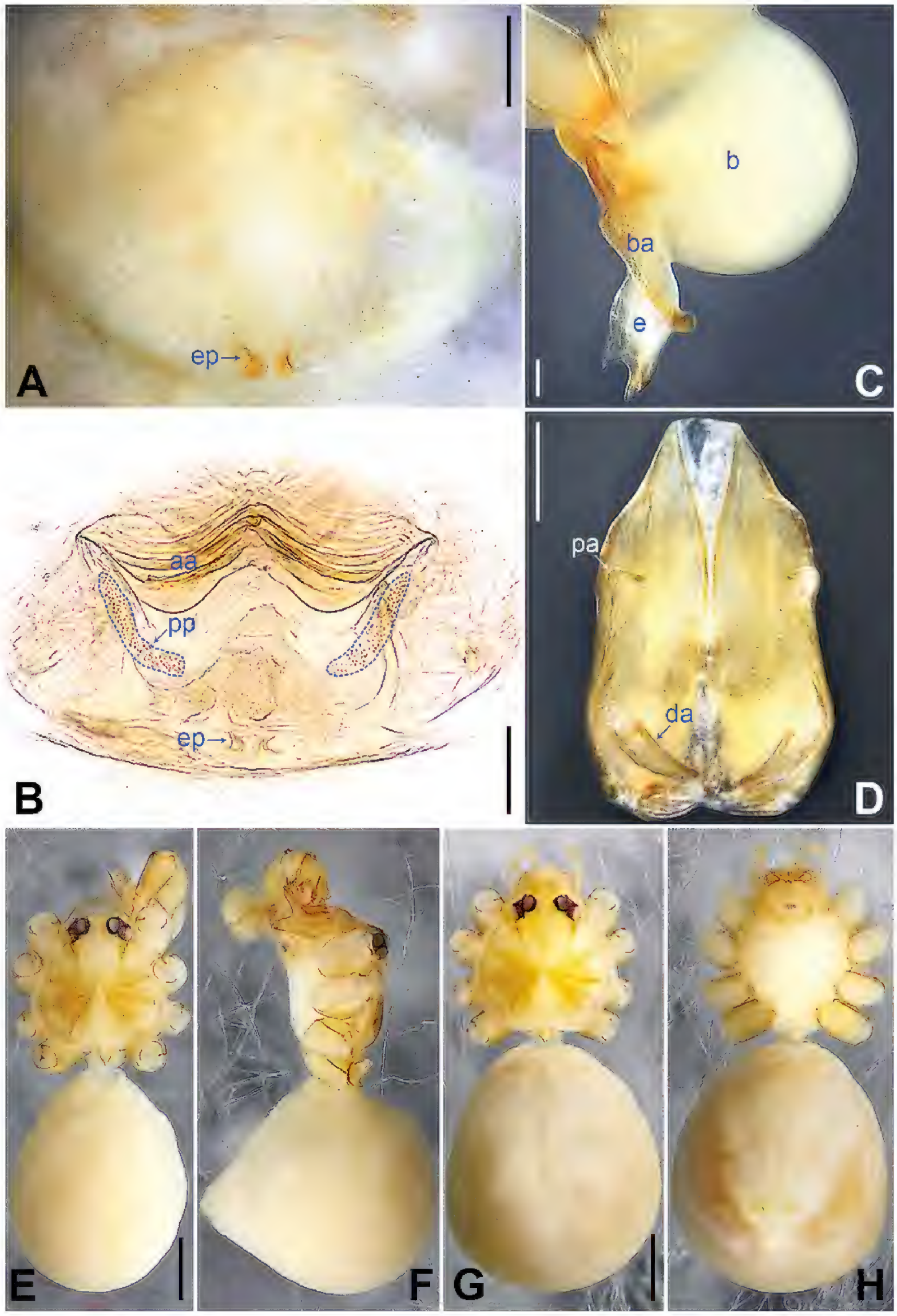


Figure 9. *Belisana nayong* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A** epigyne, ventral view **B** vulva, dorsal view **C** bulb, prolateral view **D** chelicerae, frontal view **E–H** habitus (**E, G** dorsal view **F** lateral view **H** ventral view). Abbreviations: aa = anterior arch, b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.05 (**A–D**); 0.40 (**E–H**).

hooked apophysis (ba in Fig. 9C) and simple embolus (e in Fig. 9C). Retrolateral trichobothria on tibia I at 4% proximally; legs with short vertical setae on metatarsi; tarsus I with 18 distinct pseudosegments.

Female (**paratype**, IZCAS-Ar45202): Similar to male, habitus as in Fig. 9G, H. Total length 2.47 (2.67 with clypeus), prosoma 0.81 long, 0.88 wide, opisthosoma 1.66 long, 1.40 wide; tibia I: 4.65; tibia I L/d: 58. Eye interdistances and diameters: PME–PME 0.11, PME 0.10, PME–ALE 0.02. Sternum width/length: 0.68/0.64. Epigyne simple and flat, posteriorly curved, with pair of postero-median pockets 0.02 apart (ep in Figs 9A, 24G). Vulva with ridge-shaped anterior arch (aa in Figs 9B, 24H) and pair of curved, long elliptic pore plates (8× longer than wide, pp in Figs 9B, 24H).

Variation. Tibia I in three male paratypes (IZCAS-Ar45199–201): 6.15, 6.35, 6.50. Tibia I in the other three female paratypes (IZCAS-Ar45203–05): 4.45, 4.50, 4.74.

Habitat. The species was found in the dark zone inside the cave.

Distribution. China (Guizhou, type locality; Fig. 1).

Etymology. The specific name refers to the type locality; noun in apposition.

Belisana qixingguan **Wang, S. Li & Yao, sp. nov.**

https://zoobank.org/36AE89A6-13DA-416B-9C06-C86DD3300EC4

Figs 10, 11, 22I, J, 24I, J

Type material. ***Holotype*****: China** • ♂; Guizhou, Bijie, Qixingguan District, Changchun Town, Changchun Village, Changchun Cave; 27°13.904'N, 105°10.397'E; alt. 1580 m; 29 Apr. 2007; J. Liu & Y. Lin leg.; IZCAS-Ar45206. ***Paratypes*****: China** • 7♀; same data as for holotype; IZCAS-Ar45207–13.

Diagnosis. The new species resembles *B. tongi* Zhang, Li & Yao, 2024 (Zhang et al. 2024b: 273, figs 12A–D, 13A–H, 18K, L, 21C, D) by having similar distal part of procursus (distal membranous process nearly half-round; arrow 1 in Figs 10C, 22I), bulbal apophysis (hooked; Fig. 11C), and epigyne (epigynal pockets on postero-lateral part of epigynal plate, epigynal plate posteriorly curved; Figs 11A, 24I), but can be distinguished by procursus without distal membranous lamella (Figs 10C, 22I vs present), by male cheliceral distal apophyses pointing downwards (da in Fig. 11D vs outwards), by vulva without teeth (Figs 11B, 24J vs present), and by vulval pore plates medially narrow and posteriorly strongly widened (pp in Figs 11B, 24J vs nearly triangular).

Description. Male (**holotype**): Total length 1.78 (1.89 with clypeus), prosoma 0.68 long, 0.75 wide, opisthosoma 1.10 long, 0.77 wide. Leg I: 14.43 (3.80, 0.31, 3.72, 5.00, 1.60), leg II: – (3.00, 0.31, 2.66, 3.75, –), leg III missing, leg IV: 7.17 (2.13, 0.27, 1.66, 2.41, 0.70); tibia I L/d: 50. Eye interdistances and diameters: PME–PME 0.14, PME 0.08, PME–ALE 0.02. Sternum width/length: 0.55/0.48. Habitus as in Fig. 11E, F. Dorsal shield of prosoma yellowish, with brown radiating marks; ocular area with brown median stripe; clypeus brown; sternum yellowish. Legs whitish, without darker rings. Opisthosoma yellowish, with black spots. Thoracic furrow absent. Clypeus unmodified. Chelicerae with pair of proximo-lateral apophyses (pa in Fig. 11D) and pair of curved distal apophyses (distance between tips: 0.29; da in Fig. 11D). Palp as in Fig. 10A, B; trochanter with ventral apophysis (as long as wide, arrow 1 in Fig. 10B); femur with retro-latero-proximal protrusion (arrow 2 in Fig. 10B); procursus simple, with distal membranous process (arrow 1 in Figs 10C, 22I) and subdistal spine (arrow 2 in Figs 10C, 22I); bulb with hooked apophysis (ba in Fig. 11C) and simple embolus

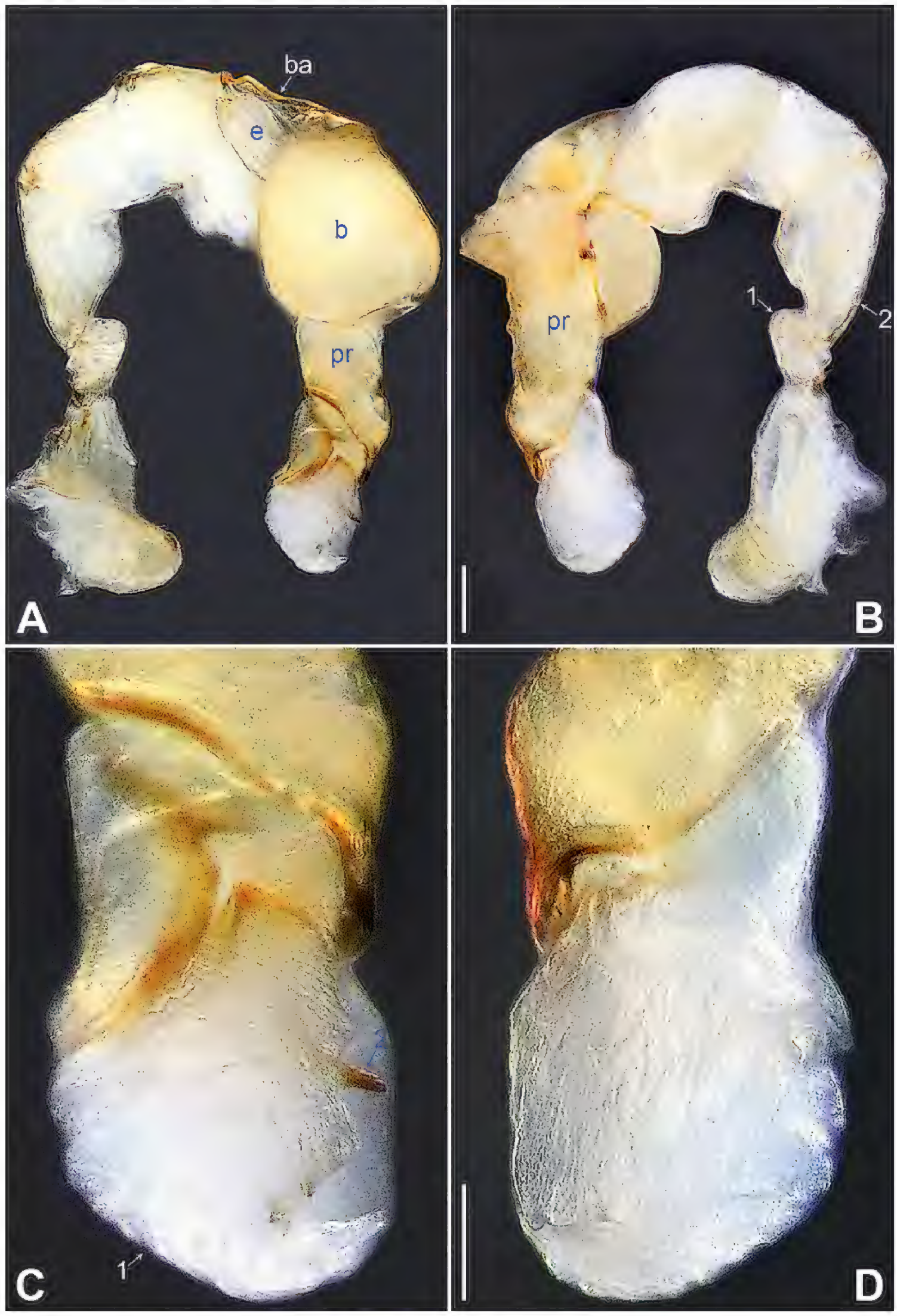


Figure 10. *Belisana qixingguan* sp. nov., holotype male **A, B** palp (**A** prolateral view **B** retrolateral view, arrow 1 points at ventral apophysis, arrow 2 points at retrolatero-proximal protrusion) **C, D** distal part of procursus (**C** prolateral view, arrow 1 points at distal membranous process, arrow 2 points at subdistal spine **D** retrolateral view). Abbreviations: b = bulb, ba = bulbal apophysis, e = embolus, pr = procursus. Scale bars: 0.10 (**A, B**); 0.05 (**C, D**).

(e in Fig. 11C). Retrolateral trichobothria on tibia I at 10% proximally; legs with short vertical setae on metatarsi; tarsus I with 15 distinct pseudosegments.

Female (**paratype**, IZCAS-Ar45207): Similar to male, habitus as in Fig. 11G, H. Total length 2.04 (2.15 with clypeus), prosoma 0.78 long, 0.81 wide, opisthosoma 1.26 long, 1.00 wide; tibia I: 3.08; tibia I L/d: 39. Eye interdistances

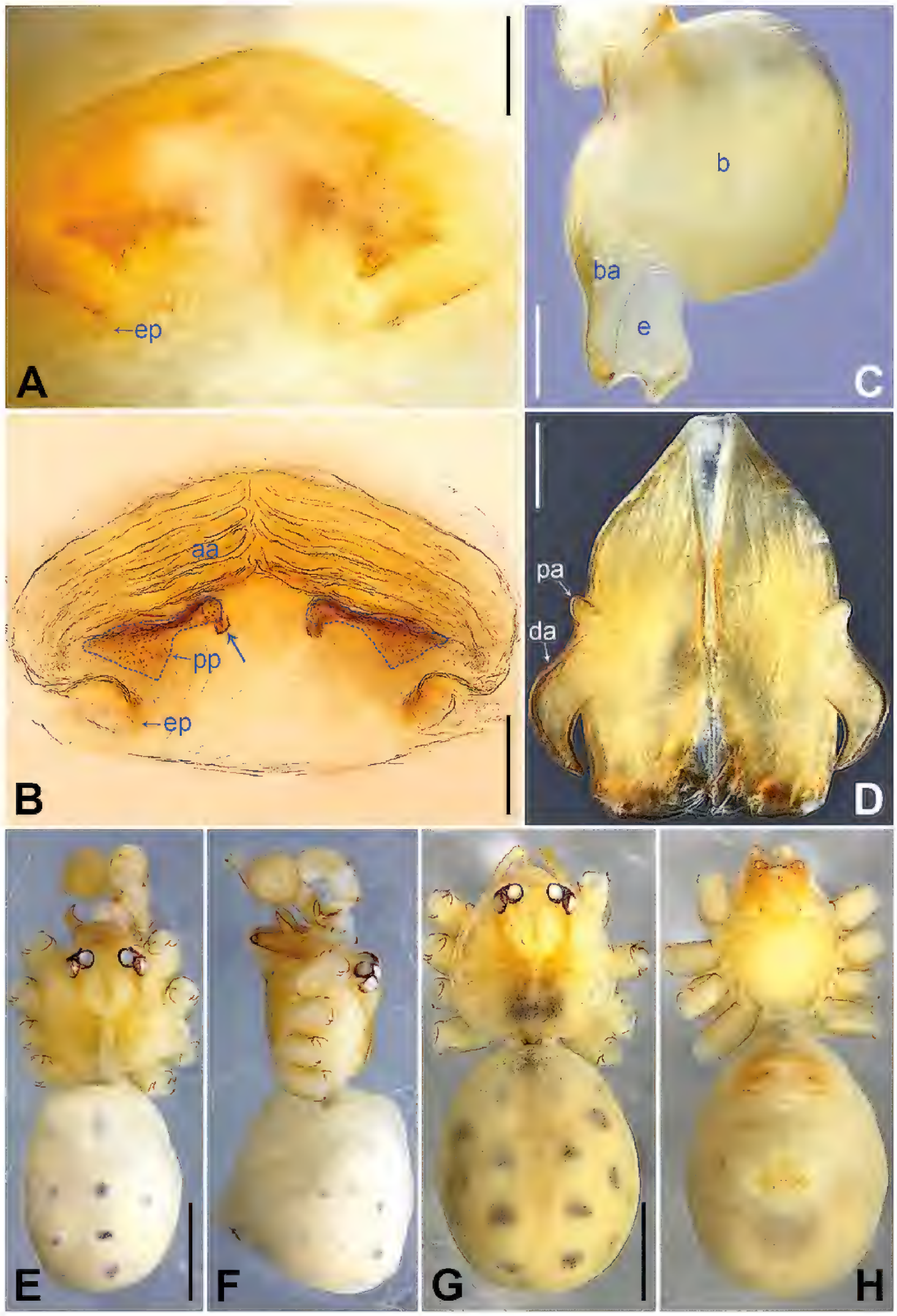


Figure 11. *Belisana qixingguan* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A** epigyne, ventral view **B** vulva, dorsal view, arrow points at sclerotized protrusion **C** bulb, prolateral view **D** chelicerae, frontal view **E–H** habitus (**E, G** dorsal view **F** lateral view **H** ventral view). Abbreviations: aa = anterior arch, b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.10 (**A–D**); 0.50 (**E–H**).

and diameters: PME–PME 0.12, PME 0.08, PME–ALE 0.02. Sternum width/length: 0.55/0.46. Epigyne simple and flat, posteriorly curved, with pair of postero-lateral pockets 0.28 apart (ep in Figs 11A, 24I). Vulva with curved anterior arch (aa in Figs 11B, 24J), pair of medially narrow and posteriorly strongly widened pore plates (pp in Figs 11B, 24J), and pair of sclerotized protrusions (arrow in Figs 11B, 24J).

Variation. Tibia I in the other six female paratypes (IZCAS-Ar45208–13): 2.89–3.09.

Habitat. The species was found in the dark zone inside the cave.

Distribution. China (Guizhou, type locality; Fig. 1).

Etymology. The specific name refers to the type locality; noun in apposition.

***Belisana xiuwen* Wang, S. Li & Yao, sp. nov.**

https://zoobank.org/92A64C94-8BCB-4211-9EDE-4930EEC2467A

Figs 12, 13, 22K, L, 25A, B

Type material. ***Holotype*: China** • ♂; Guizhou, Guiyang, Xiuwen County, Liutong Town, Daxing Village, Duobing Cave; 27°06.552'N, 106°29.675'E; alt. 1035 m; 20 Apr. 2007; J. Liu & Y. Lin leg.; IZCAS-Ar45214. ***Paratypes*: China** • 3♀; same data as for holotype; IZCAS-Ar45215–17.

Diagnosis. The new species resembles *B. yongcong* sp. nov. (Figs 14, 15, 23A, B, 25C, D) by having similar male chelicerae (tips of distal apophyses widely separated and pointing inwards; Fig. 13D), bulbal apophysis (hooked; Fig. 13C), and epigyne (epigynal pockets on lateral part of epigynal plate, epigynal plate posteriorly curved; Figs 13A, 25A), but can be distinguished by procursus with distal spine (arrow 1 in Figs 12C, 22K vs absent) and without ventro-subdistal membranous lamella, prolatero-distal membranous lamella, and sclerotized dorso-subdistal apophysis (Figs 12C, 22K vs present), and by vulval pore plates long elliptic (3× longer than wide, pp in Figs 13B, 25B vs curved and 9×).

Description. Male (**holotype**): Total length 1.35 (1.48 with clypeus), prosoma 0.57 long, 0.59 wide, opisthosoma 0.78 long, 0.60 wide. Leg I: 10.06 (2.48, 0.21, 2.73, 3.36, 1.28), leg II: 6.94 (2.00, 0.22, 1.74, 2.18, 0.80), leg III: 5.08 (1.50, 0.20, 1.14, 1.64, 0.60), leg IV: 6.72 (1.94, 0.20, 1.72, 2.15, 0.71); tibia I L/d: 46. Eye interdistances and diameters: PME–PME 0.09, PME 0.05, PME–ALE 0.02. Sternum width/length: 0.45/0.40. Habitus as in Fig. 13E, F. Dorsal shield of prosoma yellowish, without marks; clypeus and sternum yellowish. Legs whitish, without darker rings. Opisthosoma yellowish, without spots. Thoracic furrow absent. Clypeus unmodified. Eye pigments indistinct. Chelicerae with pair of proximo-lateral apophyses (pa in Fig. 13D) and pair of curved distal apophyses (distance between tips: 0.30; da in Fig. 13D). Palp as in Fig. 12A, B; trochanter with ventral apophysis (as long as wide, arrow 1 in Fig. 12B); femur with retro-latero-proximal protrusion (arrow 2 in Fig. 12B); procursus simple, with distal spine (arrow 1 in Figs 12C, 22K) and retrolateral membranous flap (f in Figs 12D, 22L); bulb with hooked apophysis (ba in Fig. 13C) and simple embolus (e in Fig. 13C). Retrolateral trichobothria on tibia I at 6% proximally; legs with short vertical setae on metatarsi; tarsus I with 15 distinct pseudosegments.

Female (**paratype**, IZCAS-Ar45215): Similar to male, habitus as in Fig. 13G, H. Total length 1.75 (1.85 with clypeus), prosoma 0.56 long, 0.59 wide, opisthosoma 1.19 long, 0.80 wide; tibia I: 2.19; tibia I L/d: 44. Eye interdistances and diameters: PME–PME 0.09, PME 0.05, PME–ALE 0.02. Sternum width/length: 0.44/0.38. Epigyne simple and flat, posteriorly curved, with pair of lateral pockets 0.33 apart (ep in Figs 13A, 25A). Vulva with ridge-shaped anterior arch (aa in Figs 13B, 25B) and pair of long elliptic pore plates (3× longer than wide, pp in Figs 13B, 25B).

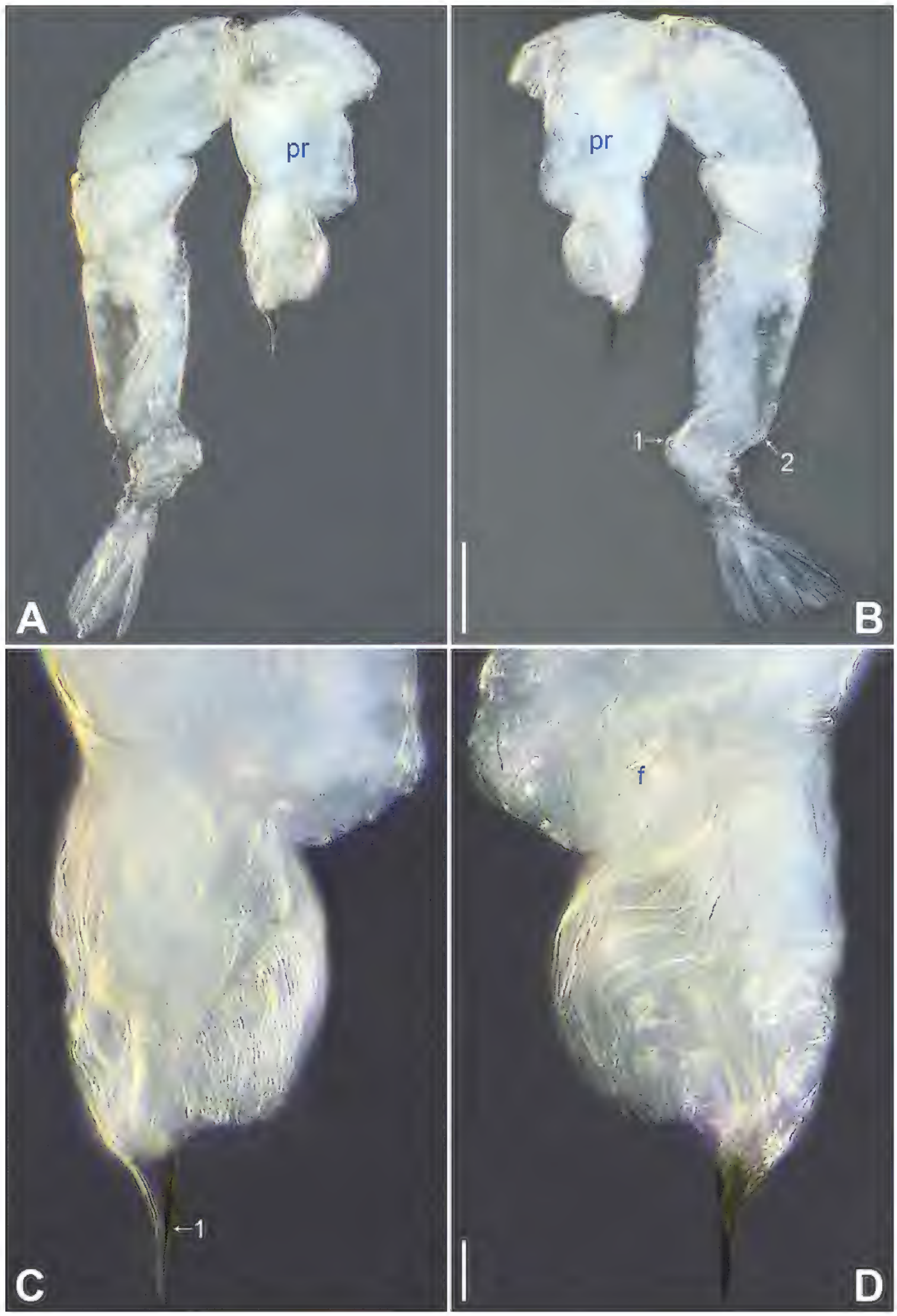


Figure 12. *Belisana xiuwen* sp. nov., holotype male **A, B** palp (**A** prolateral view **B** retrolateral view, arrow 1 points at ventral apophysis, arrow 2 points at retrolatero-proximal protrusion) **C, D** distal part of procursus (**C** prolateral view, arrow 1 points at distal spine **D** retrolateral view). Abbreviations: f = flap, pr = procursus. Scale bars: 0.10 (**A, B**); 0.02 (**C, D**).

Variation. Tibia I in the other two female paratypes (IZCAS-Ar45216–17): 2.10, 2.18.

Habitat. The species was found in the dark zone inside the cave.

Distribution. China (Guizhou, type locality; Fig. 1).

Etymology. The specific name refers to the type locality; noun in apposition.

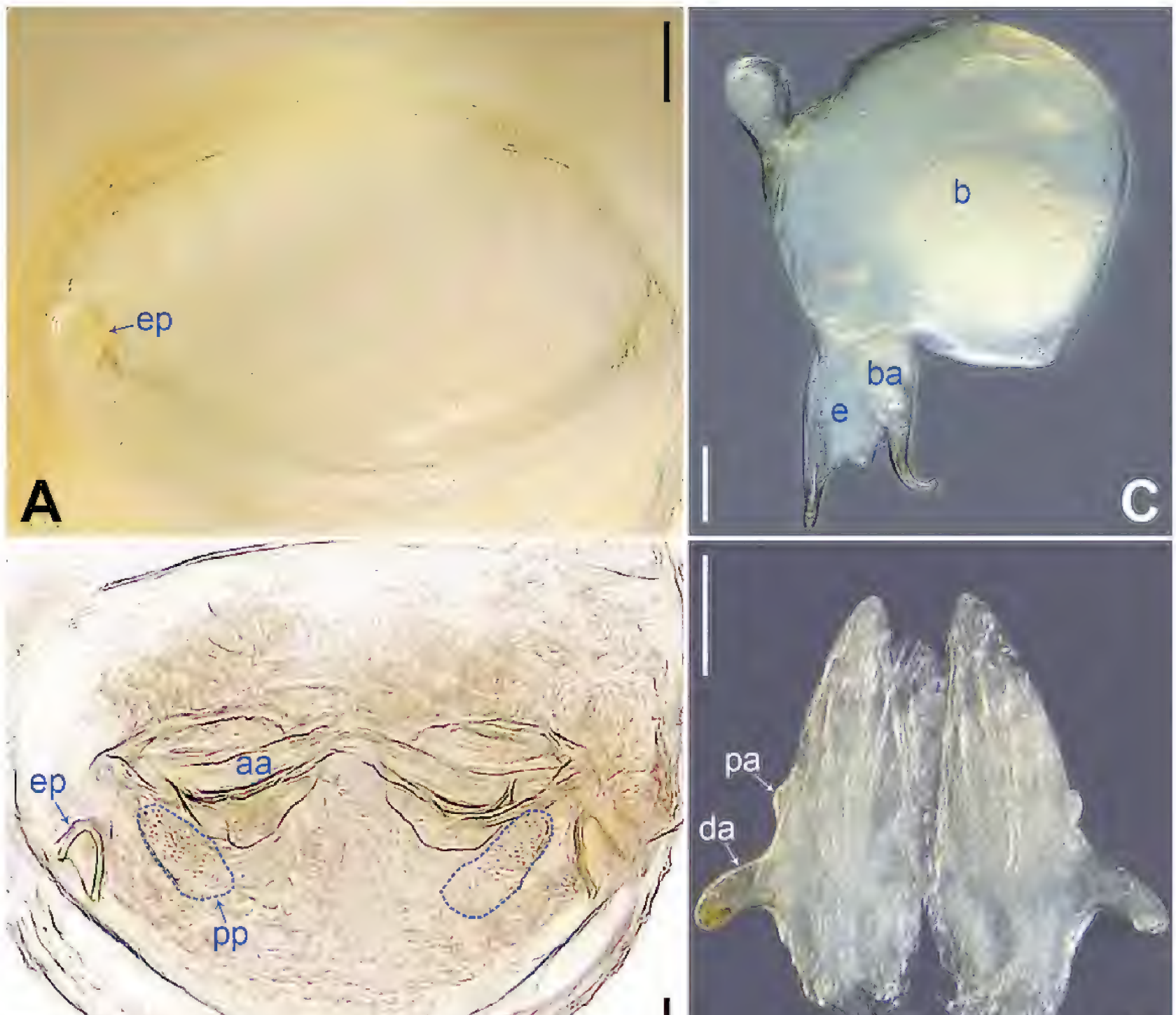


Figure 13. *Belisana xiuwen* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A** epigyne, ventral view **B** vulva, dorsal view **C** bulb, prolateral view **D** chelicerae, frontal view **E–H** habitus (**E, G** dorsal view **F** lateral view **H** ventral view). Abbreviations: aa = anterior arch, b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.05 (**A–D**); 0.50 (**E–H**).

Belisana yongcong **Wang, S. Li & Yao, sp. nov.**
https://zoobank.org/1E1B4058-113E-48F6-9734-39D486FF0FB9
Figs 14, 15, 23A, B, 25C, D

Type material. ***Holotype*****: China** • ♂; Guizhou, Qiandongnan, Liping County, Yongcong Town, Guantuan Village, Guantuan Cave; 25°59.028'N, 109°06.979'E; alt. 544 m; 23 May 2007; J. Liu & Y. Lin leg.; IZCAS-Ar45218. ***Paratypes*****: China** • 2♂; same data as for holotype; IZCAS-Ar45219–20 • 5♀; same data as for holotype; IZCAS-Ar45221–25.

Diagnosis. The new species resembles *B. nayong* sp. nov. (Figs 8, 9, 22G, H, 24G, H) by having similar bulbal apophysis (hooked; Fig. 15C) and vulva (anterior arch ridge-shaped, pore plates curved, long elliptic and 8× longer than wide; Figs 15B, 25D), but can be distinguished by procursus with blunt ventro-subdistal membranous process (arrow 1 in Figs 14C, 23A vs pointed), by male cheliceral distal apophyses pointing outwards (da in Fig. 15D vs inwards), and by epigyne with lateral pockets (ep in Figs 15A, 25C vs postero-median).

Description. Male (**holotype**): Total length 1.73 (1.82 with clypeus), prosoma 0.83 long, 0.67 wide, opisthosoma 0.90 long, 0.66 wide. Leg I: 14.76 (3.60, 0.34, 4.05, 5.58, 1.56), leg II: 12.45 (3.36, 0.32, 3.08, 4.60, 1.09), leg III: 8.21 (2.38, 0.26, 1.98, 2.84, 0.75), leg IV: 10.64 (3.20, 0.26, 2.66, 3.72, 0.80); tibia I L/d: 46. Eye interdistances and diameters: PME–PME 0.06, PME 0.09, PME–ALE 0.02. Sternum width/length: 0.54/0.49. Habitus as in Fig. 15E, F. Dorsal shield of prosoma yellowish, with brownish radiating marks; clypeus and sternum yellowish. Legs whitish, without darker rings. Opisthosoma yellowish, without spots. Thoracic furrow absent. Clypeus unmodified. Chelicerae with pair of proximo-lateral apophyses (pa in Fig. 15D) and pair of curved distal apophyses (distance between tips: 0.32; da in Fig. 15D). Palp as in Fig. 14A, B; trochanter with ventral apophysis (as long as wide, arrow 1 in Fig. 14B); femur with retrolatero-proximal protrusion (arrow 2 in Fig. 14B); procursus simple proximally but complex distally, with ventro-subdistal membranous lamella (arrow 1 in Figs 14C, 23A) bearing proximally sclerotized part, prolatero-distal membranous lamella (arrow 2 in Figs 14C, 23A) bearing proximally sclerotized part, sclerotized dorso-subdistal apophysis (arrow 3 in Figs 14C, 23A), and retrolateral membranous flap (f in Figs 14D, 23B); bulb with hooked apophysis (ba in Fig. 15C) and simple embolus (e in Fig. 15C). Retrolateral trichobothria on tibia I at 10% proximally; legs with short vertical setae on metatarsi; tarsus I with 20 distinct pseudosegments.

Female (**paratype**, IZCAS-Ar45221): Similar to male, habitus as in Fig. 15G, H. Total length 2.17 (2.29 with clypeus), prosoma 0.87 long, 0.76 wide, opisthosoma 1.30 long, 1.08 wide; tibia I: 3.65; tibia I L/d: 47. Eye interdistances and diameters: PME–PME 0.09, PME 0.08, PME–ALE 0.02. Sternum width/length: 0.59/0.45. Epigyne simple and flat, posteriorly curved, with pair of lateral pockets 0.35 apart (ep in Figs 15A, 25C). Vulva with ridge-shaped anterior arch (aa in Figs 15B, 25D) and pair of curved, long elliptic pore plates (9× longer than wide, pp in Figs 15B, 25D).

Variation. Tibia I in one male paratype (IZCAS-Ar45219): 5.32 (leg I missing in IZCAS-Ar45220). Tibia I in the other four female paratypes (IZCAS-Ar45222–25): 3.76, 3.85, 3.96, 4.16.

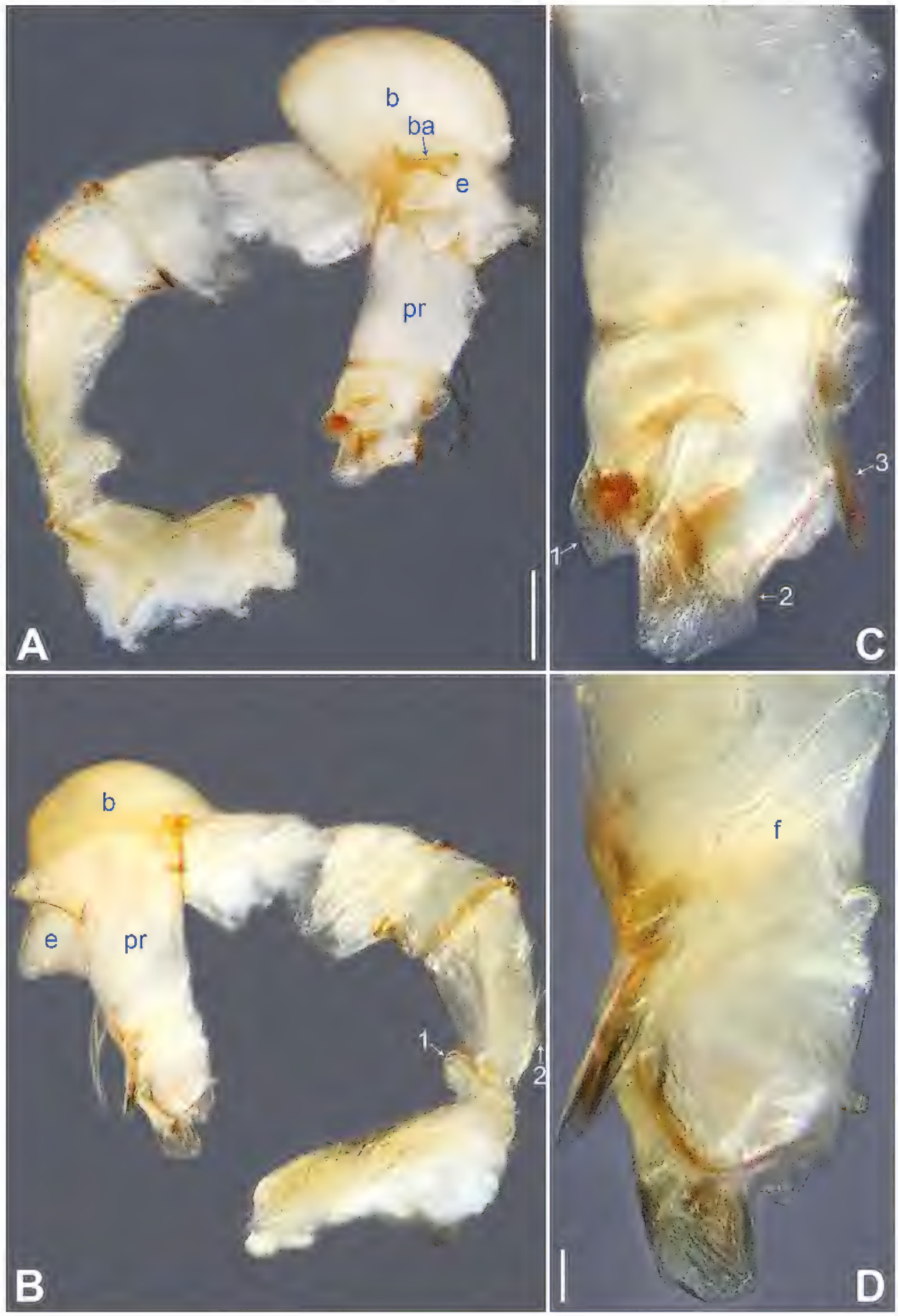
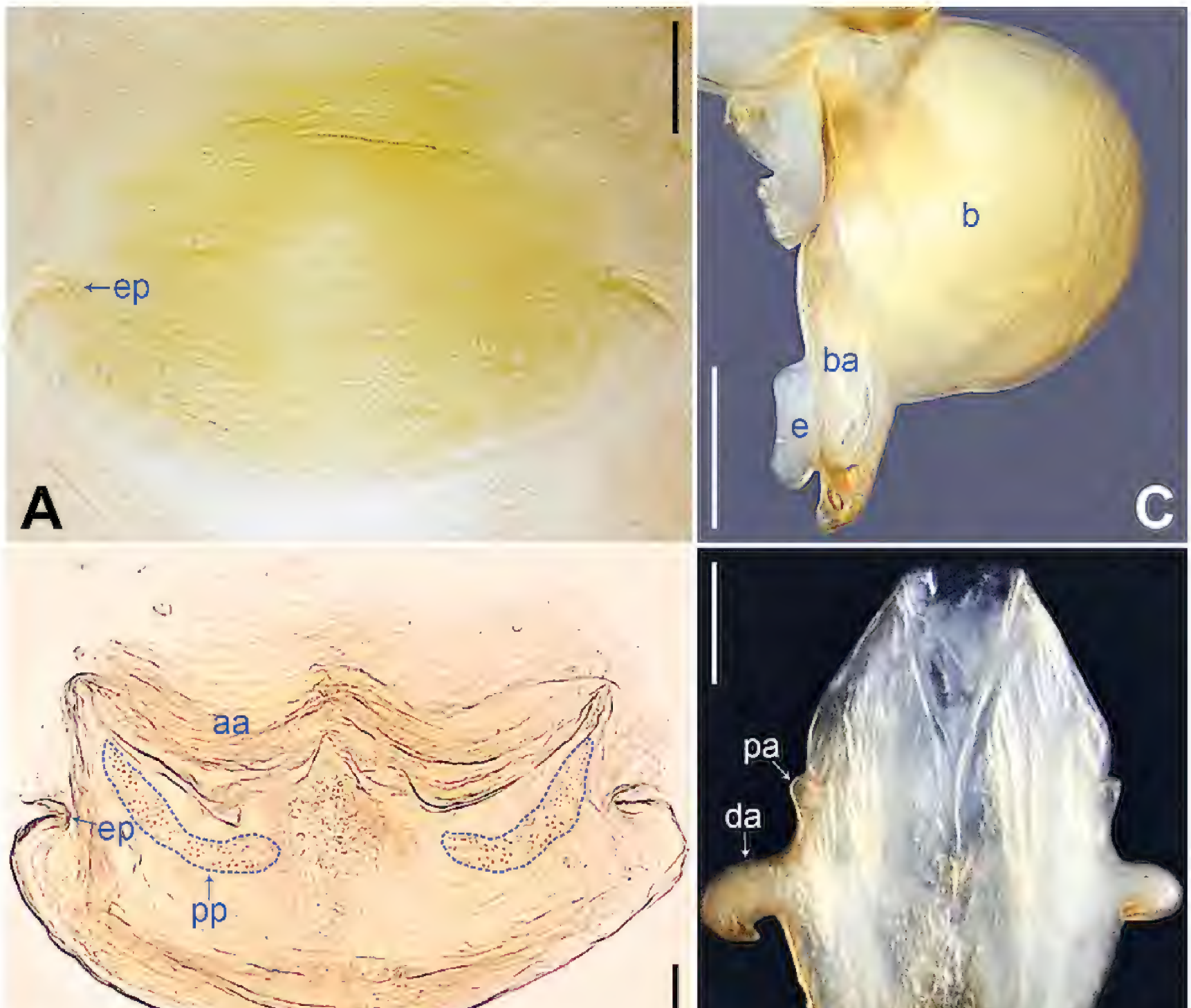


Figure 14. *Belisana yongcong* sp. nov., holotype male **A, B** palp (**A** prolateral view **B** retrolateral view, arrow 1 points at ventral apophysis, arrow 2 points at retrolatero-proximal protrusion) **C, D** distal part of procursus (**C** prolateral view, arrow 1 points at ventro-subdistal membranous lamella, arrow 2 points at prolatero-distal membranous lamella, arrow 3 points at sclerotized dorso-subdistal apophysis **D** retrolateral view). Abbreviations: b = bulb, ba = bulbal apophysis, e = embolus, f = flap, pr = procursus. Scale bars: 0.10 (**A, B**); 0.02 (**C, D**).

Habitat. The species was found in the dark zone inside the cave.
Distribution. China (Guizhou, type locality; Fig. 1).
Etymology. The specific name refers to the type locality; noun in apposition.



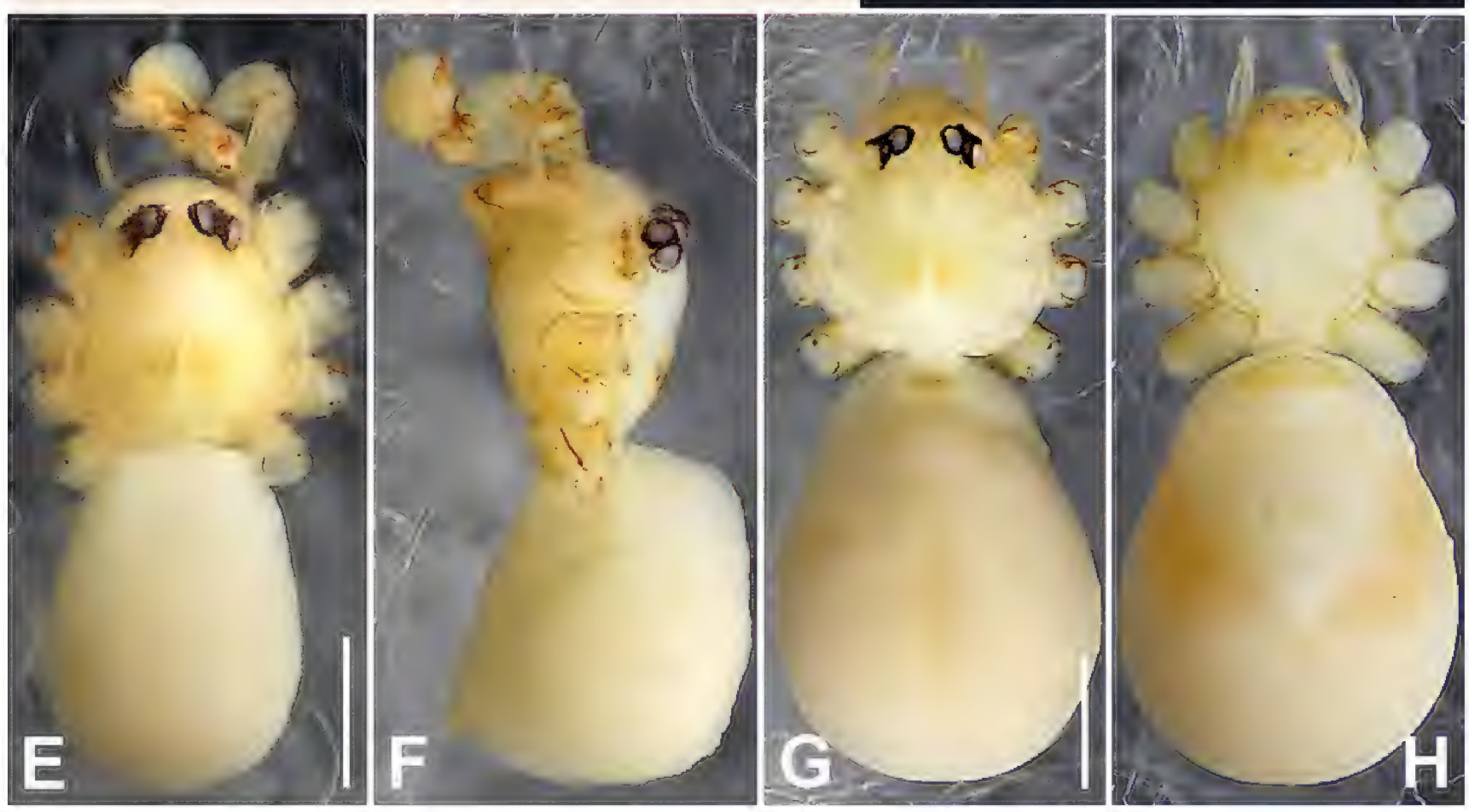


Figure 15. *Belisana yongcong* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A** epigyne, ventral view **B** vulva, dorsal view **C** bulb, prolateral view **D** chelicerae, frontal view **E–H** habitus (**E, G** dorsal view **F** lateral view **H** ventral view). Abbreviations: aa = anterior arch, b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.10 (**A–D**); 0.40 (**E–H**).

Belisana zhangi Tong & Li, 2007

Figs 16, 17, 23C, D, 25E, F

Belisana zhangi Tong and Li 2007: 505, figs 1–6.

Material examined. **China** • 1♂; Guizhou, Anshun, Puding County, Huachu Town, Jinqian Cave; 26°14.835'N, 105°37.521'E; 3 May 2005; collector unknown; IZ-CAS-Ar45177 • 3♀; same data as for preceding; IZCAS-Ar45178–80.

Diagnosis. The species resembles *B. yuhaoi* Yang & Yao, 2023 (Yang et al. 2023a: 178, figs 2A, B, 3A–D, 4A–H) by having similar bulbal apophysis (hooked; Fig. 17C) and epigyne (epigynal pockets on posterior part of epigynal plate, epigynal plate posteriorly curved; Figs 17A, 25E), but can be distinguished by procursus with nearly angular ventro-subdistal membranous lamella (arrow 1 in Figs 16C, 23C vs nearly round) and curved retrolateral membranous flap (f in Figs 16D, 23D vs angular), by male cheliceral distal apophyses pointing inwards (da in Fig. 17D vs downwards), and by vulval pore plates long elliptic (pp in Figs 17B, 25F vs nearly triangular).

Habitat. The species was found in the dark zone inside the cave.

Distribution. China (Guangxi, type locality; Guizhou, Fig. 1).

Belisana zhouxi Wang, S. Li & Yao, sp. nov.

https://zoobank.org/D2E3F0DB-7736-46DA-ADC9-9F1FC1CF3ACD

Figs 18, 19, 23E, F, 25G, H

Type material. ***Holotype*:** **China** • ♂; Guizhou, Kaili, Zhouxi Town, Hebian Cave; 26°29.280'N, 107°55.442'E; alt. 665 m; 25 May 2007; J. Liu & Y. Lin leg.; IZCAS-Ar45226. ***Paratypes*:** **China** • 2♀; same data as for holotype; IZ-CAS-Ar45227–28.

Diagnosis. The new species resembles *B. majiang* sp. nov. (Figs 6, 7, 22E, F, 24E, F) by having similar male chelicerae (tips of distal apophyses pointing downwards; Fig. 19D), bulbal apophysis (hooked; Fig. 19C), and epigyne (epigynal pockets on antero-lateral part of epigynal plate, epigynal plate posteriorly curved; Figs 19A, 25G), but can be distinguished by procursus without ventro-subdistal membranous process and dorso-distal spine (Figs 18C, 23E vs present) and by vulval pore plates elliptic (2× longer than wide, pp in Figs 19B, 25H vs 3×).

Description. Male (**holotype**): Total length 1.17 (1.27 with clypeus), prosoma 0.46 long, 0.50 wide, opisthosoma 0.71 long, 0.61 wide. Leg I: 6.72 (1.84, 0.21, 1.66, 2.13, 0.88), leg II: 4.56 (1.36, 0.19, 1.06, 1.36, 0.59), leg III: 3.29 (0.96, 0.19, 0.66, 1.01, 0.47), leg IV: 4.69 (1.44, 0.18, 1.16, 1.42, 0.49); tibia I L/d: 27. Eye interdistances and diameters: PME–PME 0.08, PME 0.06, PME–ALE 0.02. Sternum width/length: 0.41/0.33. Habitus as in Fig. 19E, F. Dorsal shield of prosoma yellowish, without marks; clypeus and sternum yellowish. Legs whitish, without darker rings. Opisthosoma yellowish, without spots. Thoracic furrow absent. Clypeus unmodified. Chelicerae with pair of proximo-lateral apophyses (pa in Fig. 19D) and pair of curved distal apophyses (distance between tips: 0.19; da in Fig. 19D). Palp as in Fig. 18A, B; trochanter with ventral apophysis (as long as wide, arrow 1 in Fig. 18B); femur with retrolatero-proximal protrusion (arrow

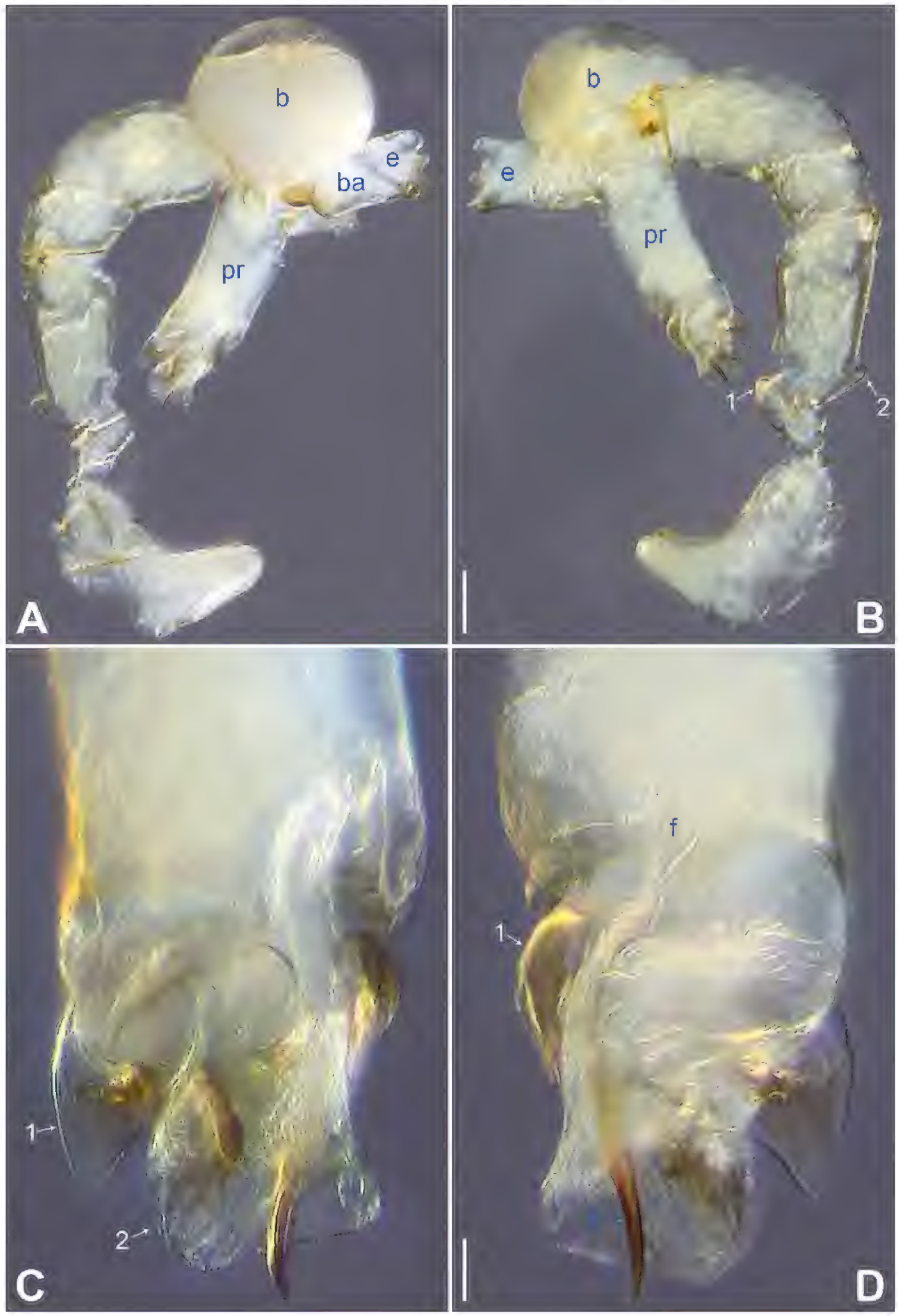


Figure 16. *Belisana zhangi* Tong & Li, 2007, male **A, B** palp (**A** prolateral view **B** retrolateral view, arrow 1 points at ventral apophysis, arrow 2 points at retrolatero-proximal protrusion) **C, D** distal part of procursus (**C** prolateral view, arrow 1 points at ventro-subdistal membranous lamella, arrow 2 points at prolatero-distal membranous lamella **D** retrolateral view, arrow 1 points at sclerotized dorso-subdistal apophysis, arrow 2 points at retrolatero-distal spine). Abbreviations: b = bulb, ba = bulbal apophysis, e = embolus, f = flap, pr = procursus. Scale bars: 0.10 (**A, B**); 0.02 (**C, D**).

2 in Fig. 18B); procursus simple proximally but complex distally, with prolatero-distal membranous lamella (arrow 1 in Figs 18C, 23E) bearing proximally slightly sclerotized part, dorso-subdistal membranous process (arrow 2 in Figs 18C, 23E), and retrolateral membranous flap (f in Figs 18D, 23F); bulb with

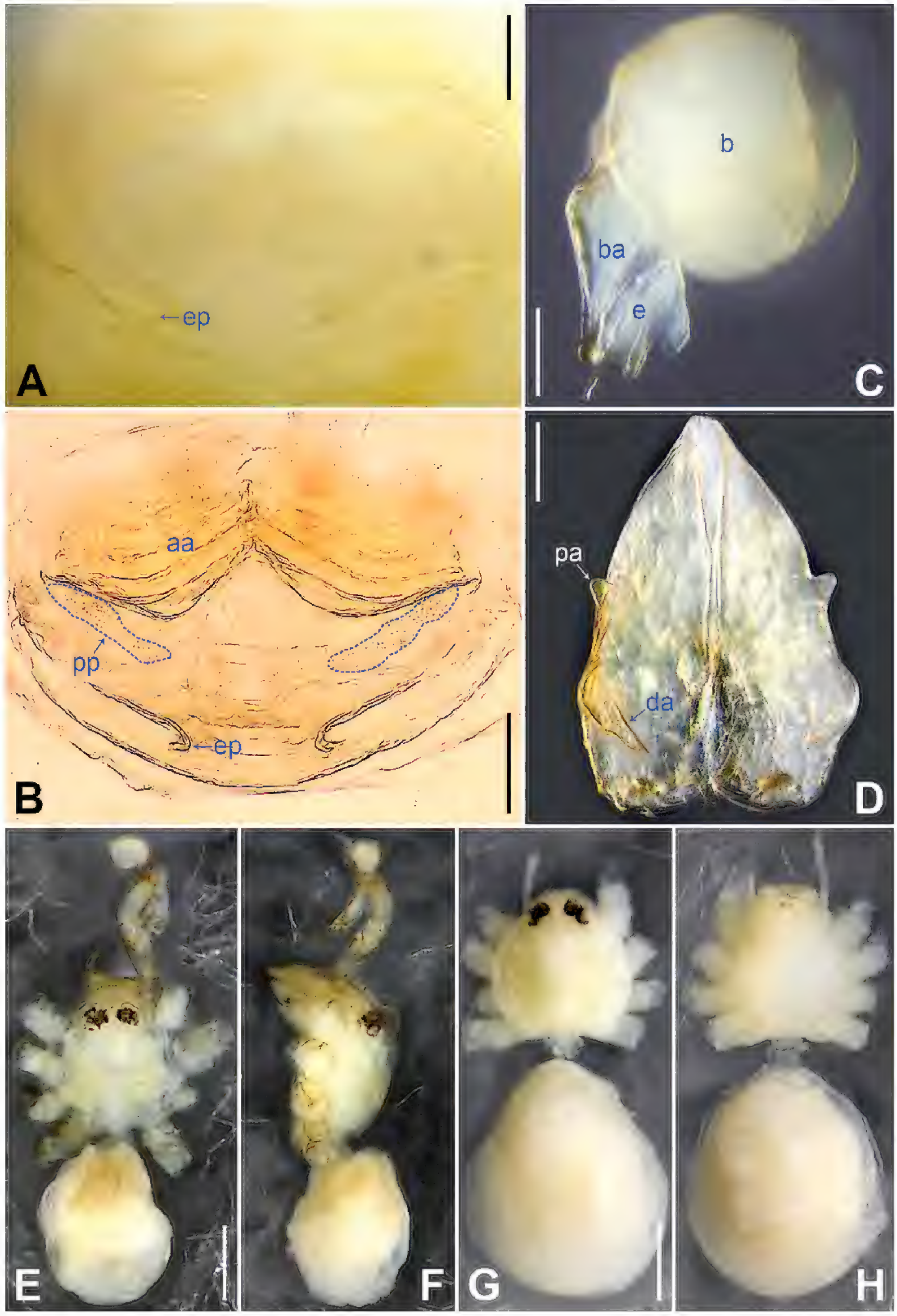


Figure 17. *Belisana zhangi* Tong & Li, 2007, male (**C–F**) and female (**A, B, G, H**) **A** epigyne, ventral view **B** vulva, dorsal view **C** bulb, prolateral view **D** chelicerae, frontal view **E–H** habitus (**E, G** dorsal view **F** lateral view **H** ventral view). Abbreviations: aa = anterior arch, b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.10 (**A–D**); 0.40 (**E–H**).

hooked apophysis (ba in Fig. 19C) and simple embolus (e in Fig. 19C). Retrolateral trichobothria on tibia I at 7% proximally; legs with short vertical setae on metatarsi; tarsus I with 14 distinct pseudosegments.

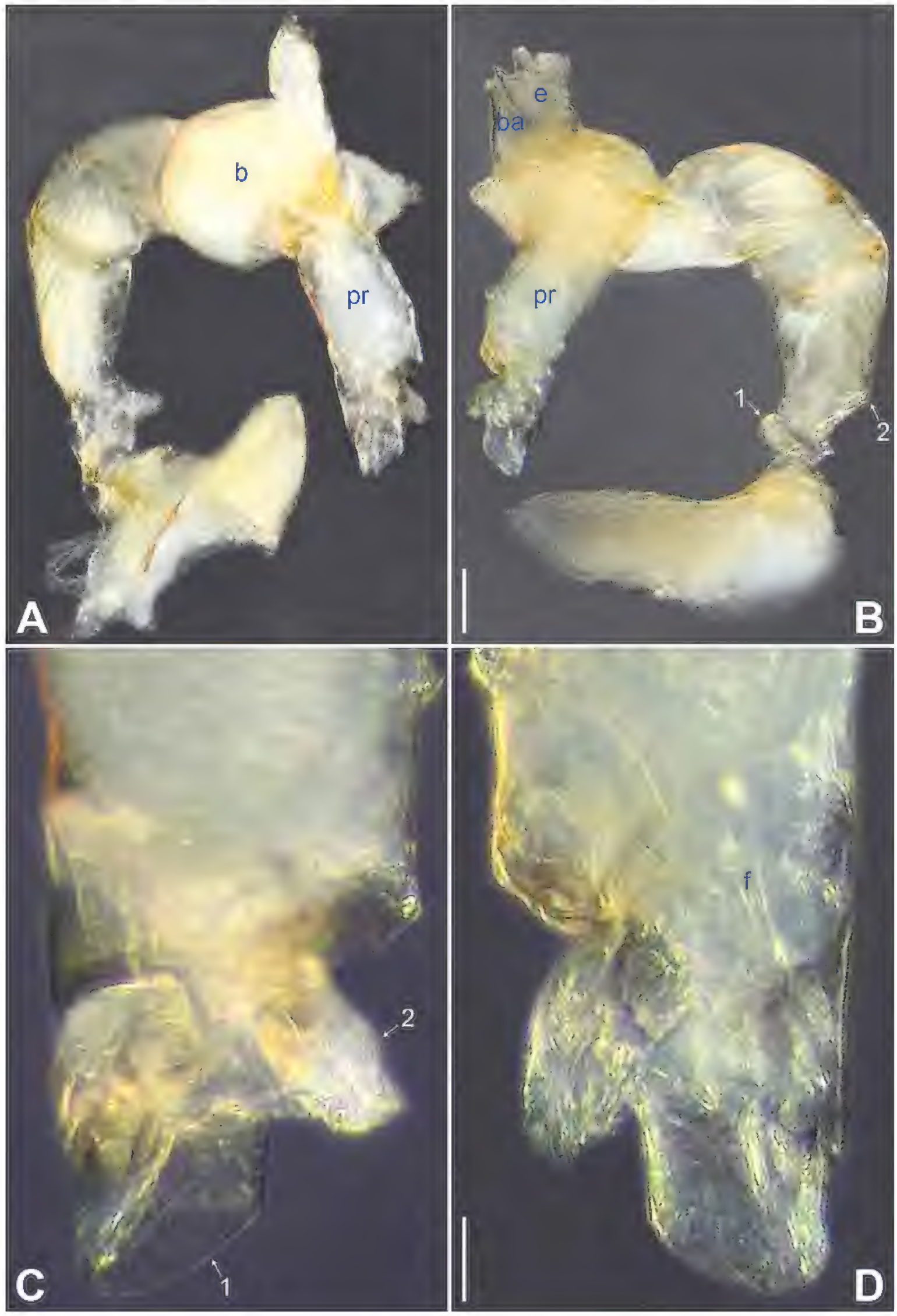


Figure 18. *Belisana zhouxi* sp. nov., holotype male **A, B** palp (**A** prolateral view **B** retrolateral view, arrow 1 points at ventral apophysis, arrow 2 points at retrolatero-proximal protrusion) **C, D** distal part of procursus (**C** prolateral view, arrow 1 points at prolatero-distal membranous lamella, arrow 2 points at dorso-subdistal membranous process **D** retrolateral view). Abbreviations: b = bulb, ba = bulbal apophysis, e = embolus, f = flap, pr = procursus. Scale bars: 0.05 (**A, B**); 0.02 (**C, D**).

Female (**paratype**, IZCAS-Ar45227): Similar to male, habitus as in Fig. 19G, H. Total length 1.21 (1.31 with clypeus), prosoma 0.49 long, 0.57 wide, opisthosoma 0.72 long, 0.63 wide; tibia I: 1.22; tibia I L/d: 22. Eye interdistances and diameters: PME–PME 0.07, PME 0.06, PME–ALE 0.01. Sternum width/

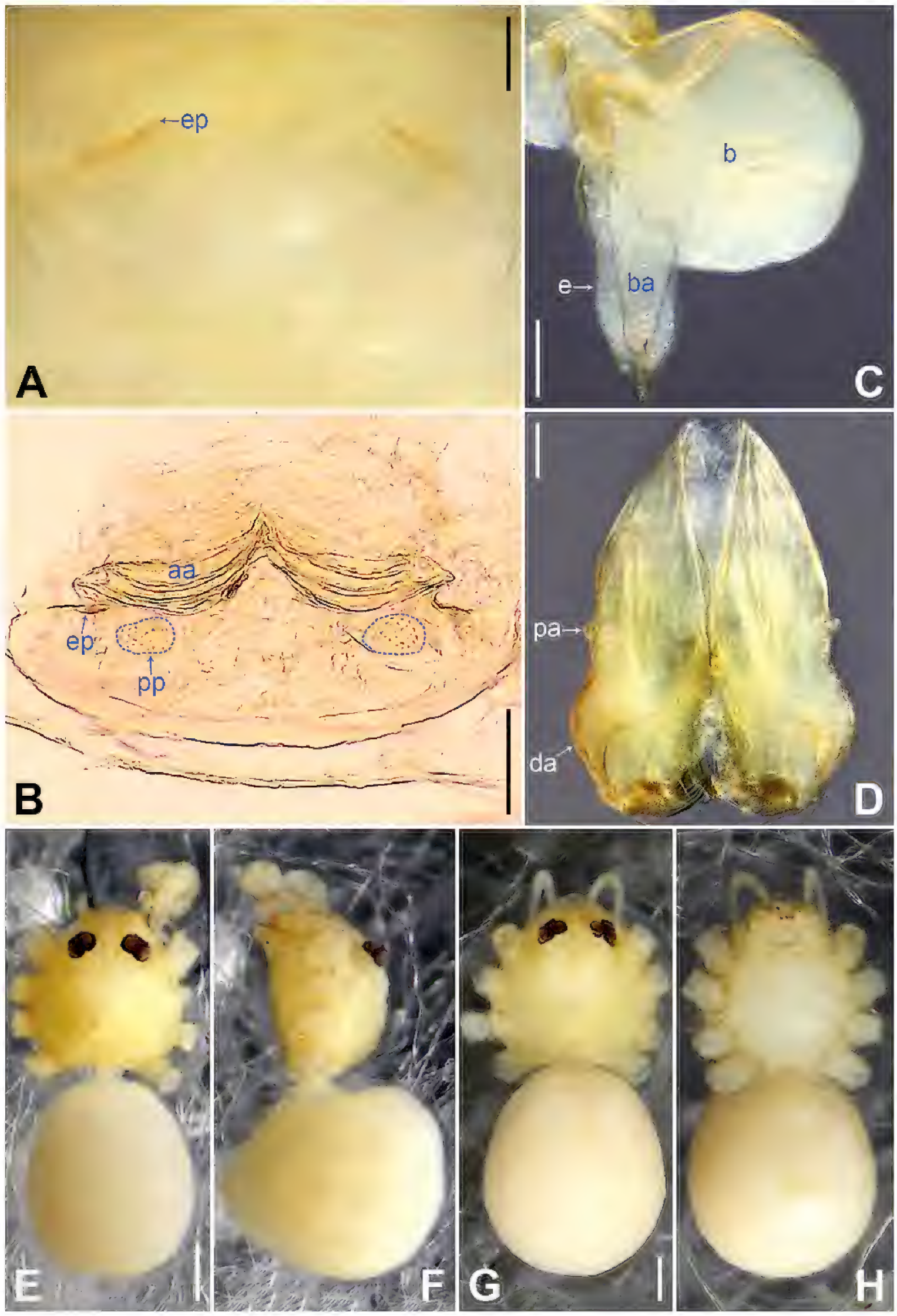


Figure 19. *Belisana zhouxi* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A** epigyne, ventral view **B** vulva, dorsal view **C** bulb, prolateral view **D** chelicerae, frontal view **E–H** habitus (**E, G** dorsal view **F** lateral view **H** ventral view). Abbreviations: aa = anterior arch, b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.05 (**A–D**); 0.20 (**E–H**).

length: 0.43/0.32. Epigyne simple and flat, posteriorly curved, with pair of antero-lateral pockets 0.16 apart (ep in Figs 19A, 25G). Vulva with ridge-shaped anterior arch (aa in Figs 19B, 25H) and pair of elliptic pore plates (2× longer than wide, pp in Figs 19B, 25H).

Variation. Unknown. Leg I missing in another female paratype (IZCAS-Ar45228).

Habitat. The species was found in the dark zone inside the cave.

Distribution. China (Guizhou, type locality; Fig. 1).

Etymology. The specific name refers to the type locality; noun in apposition.

***Belisana zunyi* Wang, S. Li & Yao, sp. nov.**

https://zoobank.org/7A299DDB-C11D-4D42-8354-65D16BC50C90

Figs 20, 21, 23G, H, 25I, J

Type material. ***Holotype*: China** • ♂; Guizhou, Zunyi, Tongzi County, Leishanguan Town, Yangliuping Village; 28°08.692'N, 106°47.378'E; alt. 1008 m; 11 May 2007; J. Liu & Y. Lin leg.; IZCAS-Ar45229. ***Paratypes*: China** • 4♂; same data as for holotype; IZCAS-Ar45230–33 • 13♀; same data as for holotype; IZCAS-Ar45234–46.

Diagnosis. The new species resembles *B. zhangi* Tong & Li, 2007 (Tong and Li 2007: 505, figs 1–6) by having similar bulbal apophysis (hooked; Fig. 21C) and vulva (anterior arch ridge-shaped, pore plates long elliptic and 6× longer than wide; Figs 21B, 25J), but can be distinguished by procursus with dorso-subdistal membranous process (arrow 3 in Figs 20C, 23G vs sclerotized apophysis) and without ventro-subdistal membranous lamella (Figs 20C, 23G vs present), by tips of male cheliceral distal apophyses close to each other (da in Fig. 21D vs widely separated), and by epigyne with median pockets (ep in Figs 21A, 25I vs postero-median).

Description. Male (**holotype**): Total length 1.62 (1.72 with clypeus), prosoma 0.60 long, 0.66 wide, opisthosoma 1.02 long, 0.78 wide. Leg I: 13.53 (3.60, 0.29, 3.50, 4.60, 1.54), leg II: 8.40 (2.25, 0.30, 2.08, 2.81, 0.96), leg III: 5.69 (1.64, 0.25, 1.34, 1.86, 0.60), leg IV: 7.72 (2.12, 0.24, 2.00, 2.56, 0.80); tibia I L/d: 43. Eye interdistances and diameters: PME–PME 0.09, PME 0.08, PME–ALE 0.02. Sternum width/length: 0.53/0.47. Habitus as in Fig. 21E, F. Dorsal shield of prosoma yellowish, without marks; clypeus and sternum yellowish. Legs whitish, without darker rings. Opisthosoma yellowish, without spots. Thoracic furrow absent. Clypeus unmodified. Chelicerae with pair of proximo-lateral apophyses (pa in Fig. 21D) and pair of curved distal apophyses (distance between tips: 0.04; da in Fig. 21D). Palp as in Fig. 20A, B; trochanter with ventral apophysis (as long as wide, arrow 1 in Fig. 20B); femur with retrolatero-proximal protrusion (arrow 2 in Fig. 20B); procursus simple proximally but complex distally, with prolatero-distal membranous lamella (arrow 1 in Figs 20C, 23G) bearing proximally sclerotized part, dorso-distal spine (arrow 2 in Figs 20C, 23G), dorso-subdistal membranous process (arrow 3 in Figs 20C, 23G), and retrolateral membranous flap (f in Figs 20D, 23H); bulb with hooked apophysis (ba in Fig. 21C) and simple embolus (e in Fig. 21C). Retrolateral trichobothria on tibia I at 10% proximally; legs with short vertical setae on metatarsi; tarsus I with 15 distinct pseudosegments.

Female (**paratype**, IZCAS-Ar45234): Similar to male, habitus as in Fig. 21G, H. Total length 1.57 (1.66 with clypeus), prosoma 0.60 long, 0.68 wide, opisthosoma 0.97 long, 0.78 wide; tibia I: 2.33; tibia I L/d: 35. Eye interdistances and diameters: PME–PME 0.08, PME 0.06, PME–ALE 0.02. Sternum width/length:

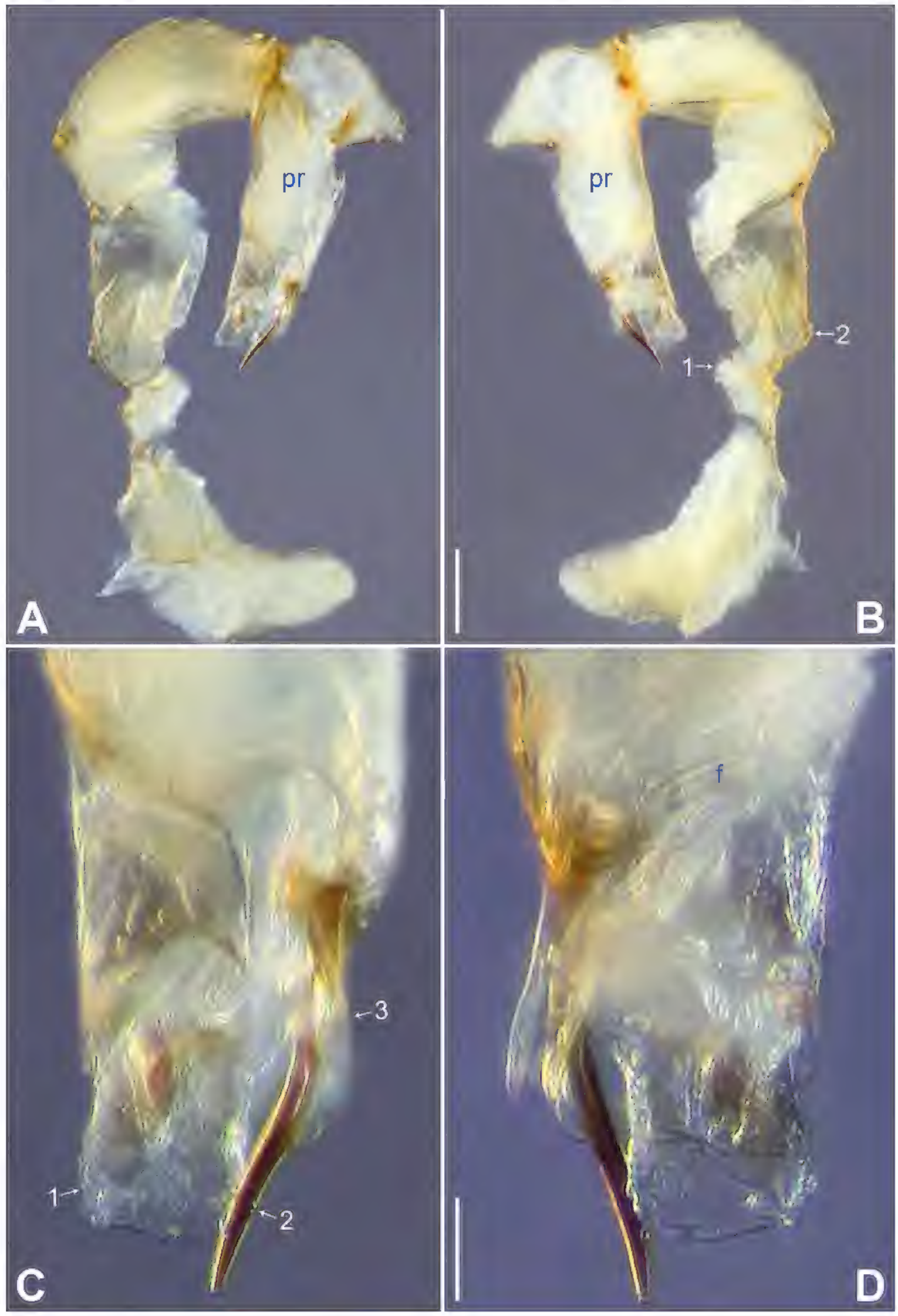
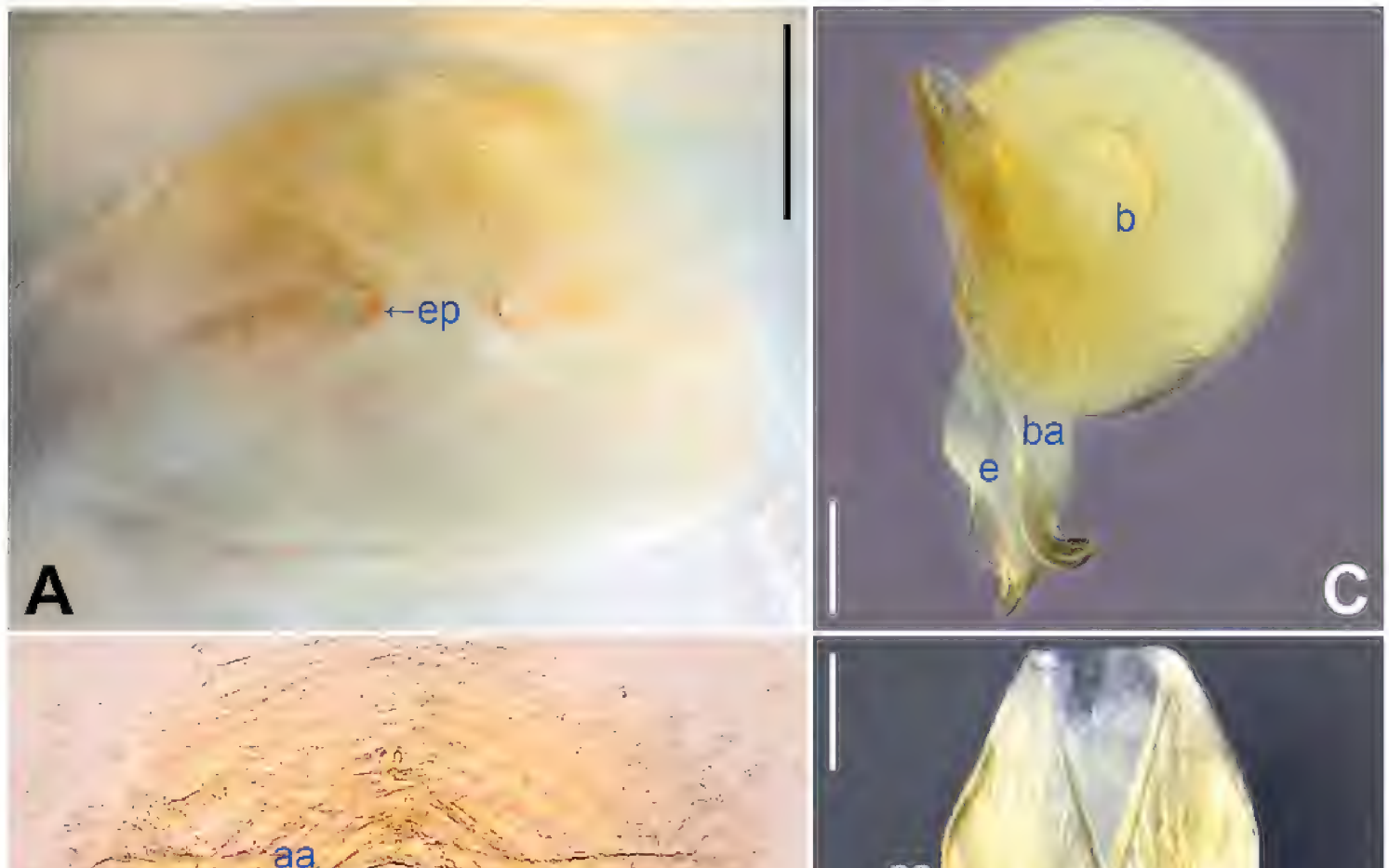


Figure 20. *Belisana zunyi* sp. nov., holotype male **A, B** palp (**A** prolateral view **B** retrolateral view, arrow 1 points at ventral apophysis, arrow 2 points at retrolatero-proximal protrusion) **C, D** distal part of procursus (**C** prolateral view, arrow 1 points at prolatero-distal membranous lamella, arrow 2 points at dorso-distal spine, arrow 3 points at dorso-subdistal membranous process **D** retrolateral view). Abbreviations: f = flap, pr = procursus. Scale bars: 0.10 (**A, B**); 0.03 (**C, D**).

0.50/0.46. Epigyne simple and flat, posteriorly straight, with pair of median pockets 0.06 apart (ep in Figs 21A, 25I). Vulva with ridge-shaped anterior arch (aa in Figs 21B, 25J) and pair of long elliptic pore plates (6× longer than wide, pp in Figs 21B, 25J).



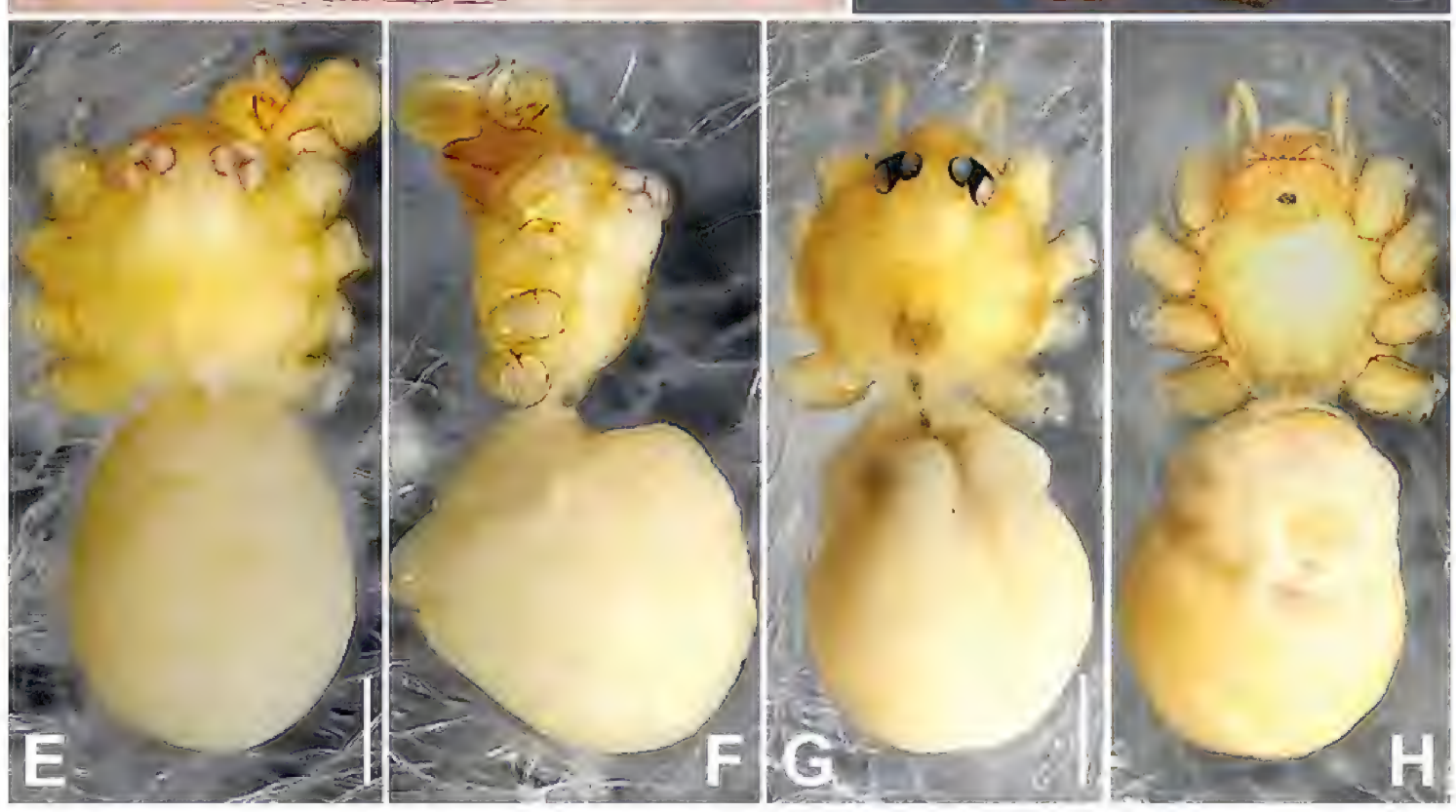


Figure 21. *Belisana zunyi* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A** epigyne, ventral view **B** vulva, dorsal view **C** bulb, prolateral view **D** chelicerae, frontal view **E–H** habitus (**E, G** dorsal view **F** lateral view **H** ventral view). Abbreviations: aa = anterior arch, b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.10 (**A–D**); 0.30 (**E–H**).

Variation. Tibia I in four male paratypes (IZCAS-Ar45230–45233): 3.12, 3.20, 3.28, 3.70. Tibia I in the other 12 female paratypes (IZCAS-Ar45235–46): 2.31–2.50.

Habitat. The species was found in the dark zone inside the cave.

Distribution. China (Guizhou, type locality; Fig. 1).

Etymology. The specific name refers to the type locality; noun in apposition.

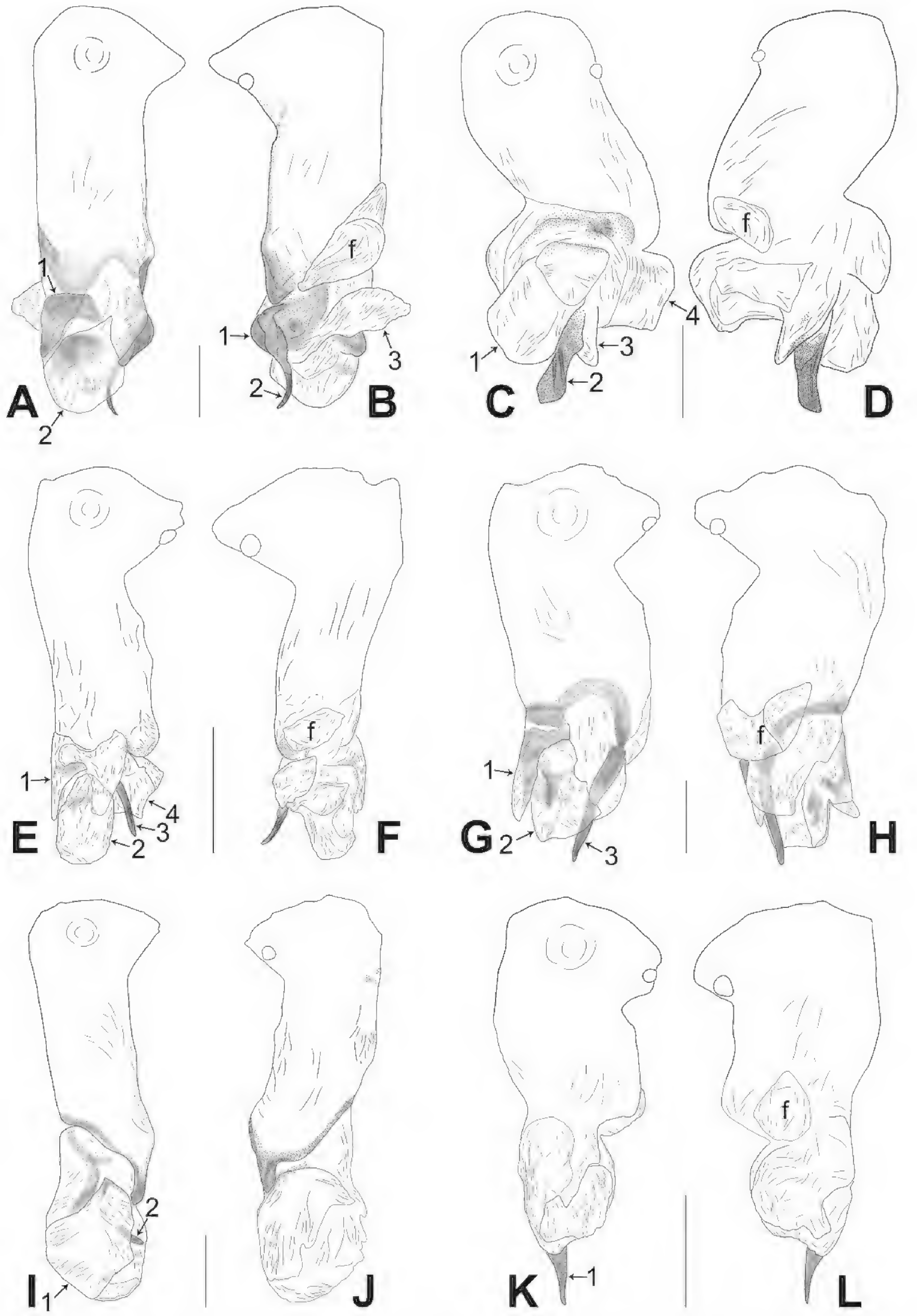


Figure 22. Procursus in prolateral and retrolateral views (The arrows point at the same structures as those shown in the photos of each species) **A, B** *Belisana bijie* sp. nov. **C, D** *B. liupanshui* sp. nov. **E, F** *B. majiang* sp. nov. **G, H** *B. nayong* sp. nov. **I, J** *B. qixingguan* sp. nov. **K, L** *B. xiuwen* sp. nov. Abbreviation: f = flap. Scale bars: 0.10.

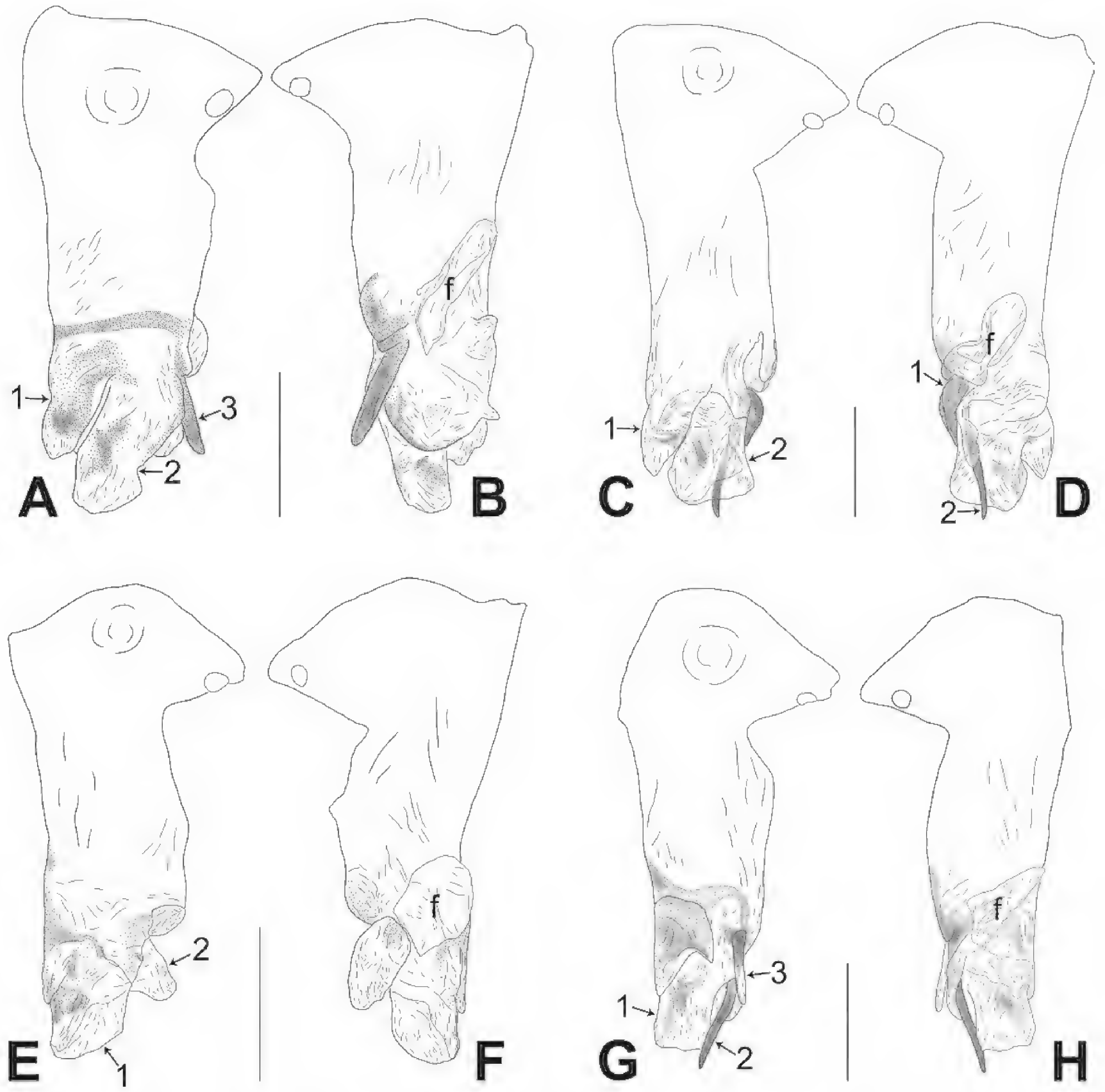


Figure 23. Procursus in prolateral and retrolateral views (The arrows point at the same structures as those shown in the photos of each species) **A, B** *Belisana yongcong* sp. nov. **C, D** *B. zhangi* Tong & Li, 2007 **E, F** *B. zhouxi* sp. nov. **G, H** *B. zunyi* sp. nov. Abbreviation: f = flap. Scale bars: 0.10.

Discussion

Belisana is highly diverse in southern China. Including the nine species described in this paper, there are now 83 species of *Belisana* in southern China, representing 49% of the global total of the genus. Thailand, Indonesia, and Vietnam rank second, third, and fourth, respectively, in species diversity of *Belisana*; however, these countries have recorded only 19, 18, and 17 species, respectively. Other countries, such as Laos (8 spp.), Malaysia (8 spp.), and Sri Lanka (6 spp.), have recorded fewer than ten species (WSC 2024). This high level of activity in China contrasts with the sporadic coverage of Southeast Asia, where most research has been conducted by foreign arachnologists, and several countries lack native expertise in this field (Yao and Li 2021; Zhang et al. 2022; Yang et al. 2023b). Given that Southeast Asia encompasses the Indo-Burma and Sundaland biodiversity hotspots, we anticipate that further exploration will reveal additional, as-yet-undiscovered species diversity of *Belisana*.

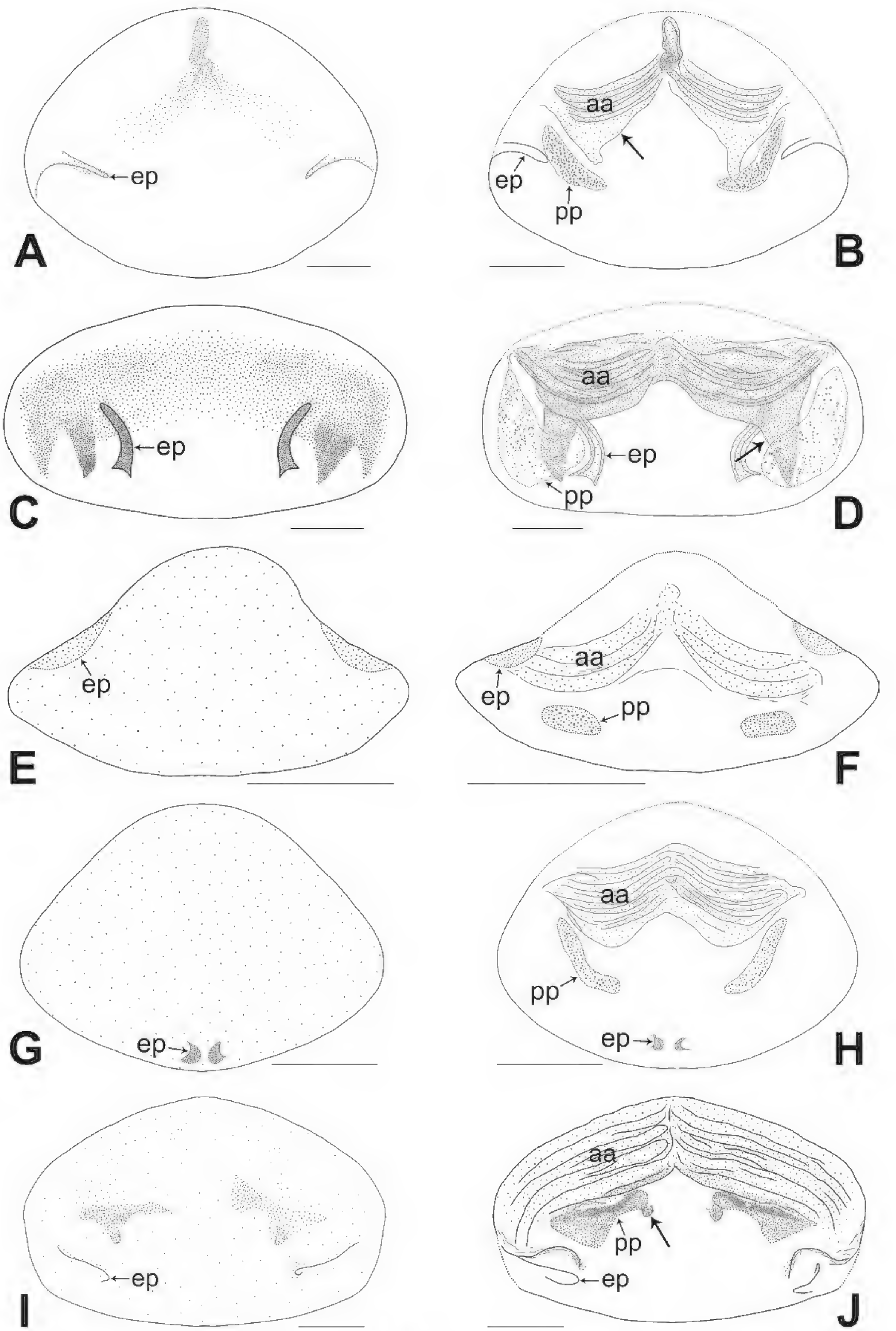


Figure 24. Female genitalia in ventral and dorsal views **A, B** *Belisana bijie* sp. nov., arrow points at lateral sclerite **C, D** *B. liupanshui* sp. nov., arrow points at lateral sclerite **E, F** *B. majiang* sp. nov. **G, H** *B. nayong* sp. nov **I, J** *B. qixingguan* sp. nov., arrow points at sclerotized protrusion. Abbreviations: aa = anterior arch, ep = epigynal pocket, pp = pore plate. Scale bars: 0.10.

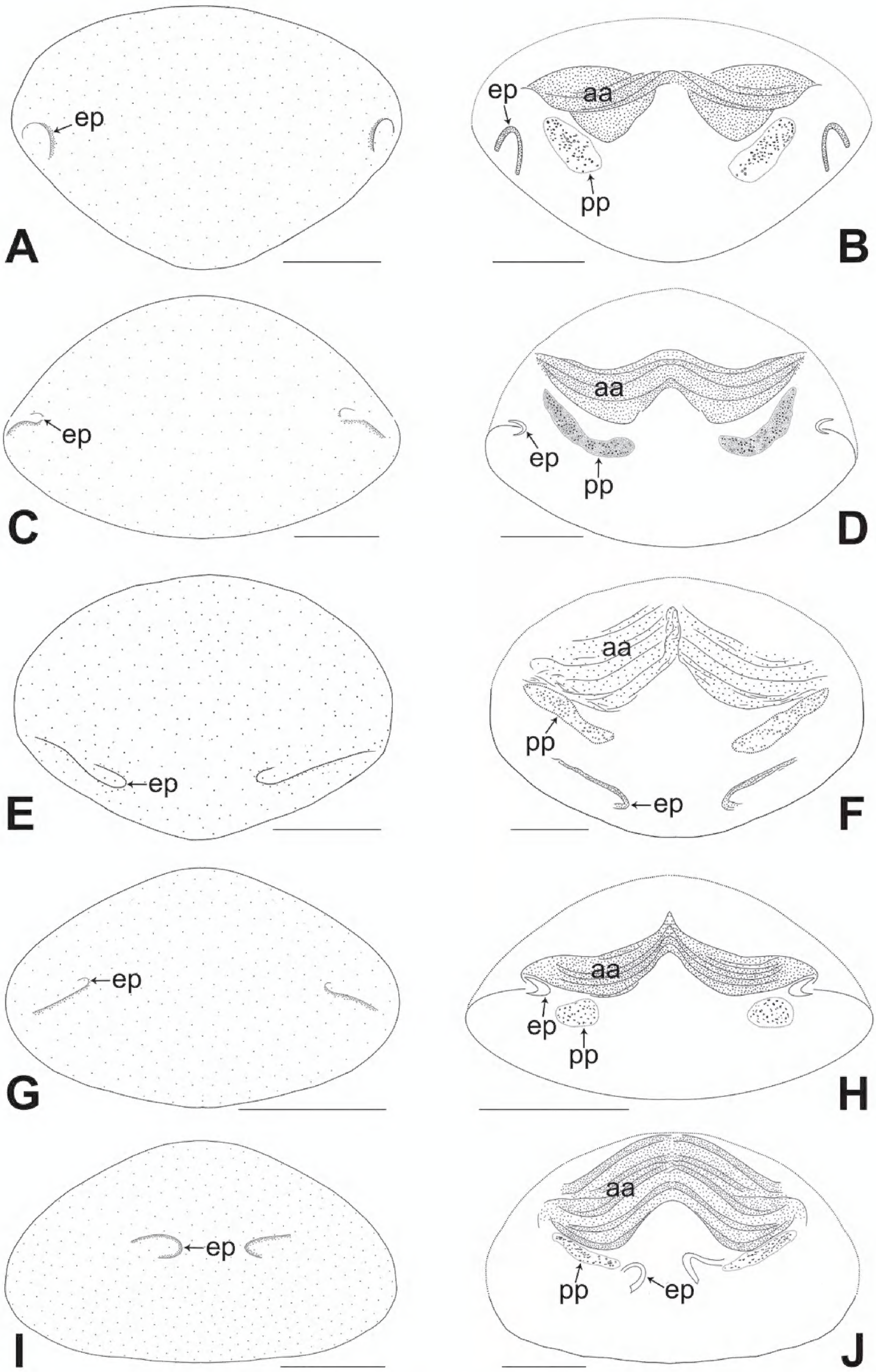


Figure 25. Female genitalia in ventral and dorsal views **A, B** *Belisana xiuwen* sp. nov. **C, D** *B. yongcong* sp. nov. **E, F** *B. zhangi* Tong & Li, 2007 **G, H** *B. zhouxi* sp. nov. **I, J** *B. zunyi* sp. nov. Abbreviations: aa = anterior arch, ep = epigynal pocket, pp = pore plate. Scale bars: 0.10.

Acknowledgements

The manuscript benefited greatly from comments by Alireza Zamani, Yanfeng Tong, and Bernhard Huber.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Funding

This study was supported by the National Natural Science Foundation of China (NSFC-32170461, 31872193).

Author contributions

ZY and SL designed the study. BW, SL, and ZY performed morphological species identification. BW and JL finished the descriptions and took the photos and drawings. ZY, BW, and SL drafted and revised the manuscript.

Author ORCIDs

Bing Wang https://orcid.org/0009-0009-7047-4395
Jinglin Li https://orcid.org/0009-0008-3932-309X
Shuqiang Li https://orcid.org/0000-0002-3290-5416
Zhiyuan Yao https://orcid.org/0000-0002-1631-0949

Data availability

All of the data that support the findings of this study are available in the main text.

References

Chen H, Zhang F, Zhu M (2009) Four new troglophilous species of the genus *Belisana* Thorell, 1898 (Araneae, Pholcidae) from Guizhou Province, China. Zootaxa 2092: 58–68. https://doi.org/10.11646/zootaxa.2092.1.5

Chen H, Yu Z, Guo X (2016) One new spider species of genus *Belisana* (Araneae: Pholcidae) from Guizhou, China. Sichuan Journal of Zoology 35(2): 227–230.

Huber BA (2005) High species diversity, male-female coevolution, and metaphyly in Southeast Asian pholcid spiders: The case of *Belisana* Thorell 1898 (Araneae, Pholcidae). Zoologica 155: 1–126.

Khmelik VV, Kozub D, Glazunov A (2005) Helicon Focus 3.10.3. https://www.heliconsoft.com/heliconsoft-products/helicon-focus/ [Accessed 6 July 2024]

Lefébure T, Douady CJ, Gouy M, Trontelj P, Briolay J, Gibert J (2006) Phylogeography of a subterranean amphipod reveals cryptic diversity and dynamic evolution in extreme environments. Molecular Ecology 15: 1797–1806. https://doi.org/10.1111/j.1365-294X.2006.02888.x

Lu Y, Chu C, Zhang X, Li S, Yao Z (2022) Europe vs China: *Pholcus* (Araneae, Pholcidae) from Yanshan-Taihang Mountains confirms uneven distribution of spiders in Eurasia.

Zoological Research 43(4): 532–534 [& Suppl. 1–78]. https://doi.org/10.24272/j.issn.2095-8137.2022.103

Tong Y, Li S (2007) A new six-eyed pholcid spider (Araneae, Pholcidae) from Karst Tiankeng of Leye County, Guangxi, China. Acta Zootaxonomica Sinica 32: 505–507.

Wang B, Yao Z, Zhang X (2024) A new spider species of *Belisana* Thorell, 1898 (Araneae, Pholcidae) from Guizhou Province, south-western China. Biodiversity Data Journal 12: e125111 [1–7]. https://doi.org/10.3897/BDJ.12.e125111

WSC (2024) World Spider Catalog, Version 25.5. Natural History Museum Bern. https://wsc.nmbe.ch [Accessed 19 September 2024]

Yang L, Zhao F, He Q, Yao Z (2023a) A survey of pholcid spiders (Araneae, Pholcidae) from Guiyang, Guizhou Province, China. ZooKeys 1186: 175–184. https://doi.org/10.3897/zookeys.1186.105736

Yang R, Yan M, Zhang L, Liu H, Koh JKH, He Q, Yao Z (2023b) New taxa of spiders (Araneae) from the world in 2022. Biodiversity Science 31(10): 23175 [1–7]. https://doi.org/10.17520/biods.2023175

Yang L, Fu C, Zhang Y, He Q, Yao Z (2024a) A survey of *Pholcus* spiders (Araneae, Pholcidae) from the Qinling Mountains of central China, with descriptions of seven new species. Zoosystematics and Evolution 100(1): 199–221. https://doi.org/10.3897/zse.100.116759

Yang L, He Q, Yao Z (2024b) Taxonomic study of four closely-related species of the *Pholcus yichengicus* species group (Araneae, Pholcidae) from China's Qinling Mountains: An integrated morphological and molecular approach. Zoosystematics and Evolution 100(1): 279–289. https://doi.org/10.3897/zse.100.115633

Yao Z, Li S (2013) New and little known pholcid spiders (Araneae: Pholcidae) from Laos. Zootaxa 3709(1): 1–51. https://doi.org/10.11646/zootaxa.3709.1.1

Yao Z, Li S (2021) Annual report of Chinese spider taxonomy in 2020. Biodiversity Science 29(8): 1058–1063. https://doi.org/10.17520/biods.2021140

Yao Z, Pham DS, Li S (2015) Pholcid spiders (Araneae: Pholcidae) from northern Vietnam, with descriptions of nineteen new species. Zootaxa 3909(1): 1–82. https://doi.org/10.11646/zootaxa.3909.1.1

Yao Z, Dong T, Zheng G, Fu J, Li S (2016) High endemism at cave entrances: a case study of spiders of the genus *Uthina*. Scientific Reports 6: 35757 [1–9 & Suppl. I–LII]. https://doi.org/10.1038/srep35757

Yao Z, Zhu K, Du Z, Li S (2018) The *Belisana* spiders (Araneae: Pholcidae) from Xishuangbanna Tropical Botanical Garden, Yunnan, China. Zootaxa 4425(2): 243–262. https://doi.org/10.11646/zootaxa.4425.2.3

Yao Z, Wang X, Li S (2021) Tip of the iceberg: species diversity of *Pholcus* spiders (Araneae, Pholcidae) in the Changbai Mountains, northeast China. Zoological Research 42(3): 267–271 [& Suppl. 1–60]. https://doi.org/10.24272/j.issn.2095-8137.2021.037

Zhang F, Peng Y (2011) Eleven new species of the genus *Belisana* Thorell (Araneae: Pholcidae) from south China. Zootaxa 2989: 51–68. https://doi.org/10.11646/zootaxa.2989.1.2

Zhang Y, Chen H, Zhu M (2008) A new troglophilous *Belisana* spider from Guangxi, China (Araneae, Pholcidae). Acta Zootaxonomica Sinica 33: 654–656.

Zhang L, Lu Y, Chu C, He Q, Yao Z (2022) New spider taxa of the world in 2021. Biodiversity Science 30(8): 22163 [1–8]. https://doi.org/10.17520/biods.2022163

Zhang L, Wang Y, Li S, Zhang X, Yao Z (2024a) Three new spider species of *Belisana* Thorell, 1898 (Araneae, Pholcidae) from karst caves, with a list of *Belisana* species

from Guangxi, China. ZooKeys 1209: 315–330. https://doi.org/10.3897/zookeys.1209.127951

Zhang L, Wu Z, Li S, Yao Z (2024b) Eight new spider species of *Belisana* Thorell, 1898 (Araneae, Pholcidae), with an updated overview of *Belisana* species from Yunnan, China. ZooKeys 1202: 255–286. https://doi.org/10.3897/zookeys.1202.121633

Zhao F, Yang L, Li S, Zheng G, Yao Z (2023a) A further study on the *Belisana* spiders (Araneae: Pholcidae) from Xishuangbanna, Yunnan, China. Zootaxa 5351(5): 543–558. https://doi.org/10.11646/zootaxa.5351.5.3

Zhao F, Yang L, Zou Q, Ali A, Li S, Yao Z (2023b) Diversity of *Pholcus* spiders (Araneae: Pholcidae) in China's Lüliang Mountains: an integrated morphological and molecular approach. Insects 14(4): 364 [1–34]. https://doi.org/10.3390/insects14040364

Zhu W, Li S (2021) Six new species of the spider genus *Belisana* (Araneae: Pholcidae) from Southeast Asia. Zootaxa 4963(1): 115–137. https://doi.org/10.11646/zootaxa.4963.1.5

Zhu W, Yao Z, Zheng G, Li S (2020) Six new species of the spider genus *Belisana* Thorell, 1898 (Araneae: Pholcidae) from southern China. Zootaxa 4810(1): 175–197. https://doi.org/10.11646/zootaxa.4810.1.12